2003 ENVIRONMENTAL PERFORMANCE REPORT

CALIFORNIA ENERGY COMMISSION

STAFF DRAFT REPORT

June 2003
100-03-010SD

Gray Davis, Governor

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Environmental Performance Report Acknowlegdements

ENVIRONMENTAL
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JUNE 2003

Acknowledgements

We would like to thank the following individuals who participated in preparing this report. The Energy Commission staff members include:

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Environmental Performance Report
Table of Contents

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Table of Contents

List of Tables

List of Figures

Environmental Performance Report Executive Summary

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

June 2003

Executive Summary

This report assesses the environmental performance and related impacts of California's electric generation facilities, and updates the status and trends that were initially reported in the ***2001 Environmental Performance Report***. In addition, as provided in section 25503(b) of the Public Resources Code, this report has been prepared as part of the first Integrated Energy Policy Report. That report and its subsidiary reports are due to be submitted to the Governor and Legislature by November 1, 2003, and every two years thereafter.

This Staff Draft of the ***2003 Environmental Performance Report*** provides the analytical basis for policy recommendations that may be incorporated into the final version of this report and into the ***Integrated Energy Policy Report***. Interested parties are encouraged to review this staff draft report and to provide comments relating both to the report's content and to possible policy recommendations that may follow from the environmental status and trends discussed in the report.

California's electricity is supplied by a wide range of generating facilities located throughout the state, the western United States, and in Canada and Mexico. The 2001 Environmental Performance Report provided an initial evaluation of the environmental performance of the state's electric generating system from World War II to the year 2000. This report focuses on the performance of the system since 1996, when the changes deregulating the state's system were adopted into law. The Energy Commission's goal is to establish a quantified 1996 environmental baseline, from which trends in environmental performance can be monitored and assessed. This ***2003 Environmental Performance Report*** also includes a brief review of the energy crisis of 2000 and 2001, including an evaluation of the limited environmental effects of that crisis.

The report is divided into three main chapters. Following the Introduction, Chapter 2 provides an overview of the electricity system and its operation. Chapter 3 provides an analysis of the environmental performance of the system relating to air quality, biological resources, and water resources. Chapter 4 summarizes the societal effects in terms of land use compatibility, socioeconomic effects, and environmental justice issues. The report's conclusions are presented in a final chapter. The key findings of the report are summarized below.

Electricity System Overview

- California's electricity supply system includes generation provided by a diverse in-state resource base augmented by imported electricity generated from out-of-state generation facilities. The importance of natural gas-fired capacity in California has continued to increase as the use of natural gas as fuel dominates new capacity additions.
- California has 55,800 MW of in-state generation capacity. Natural gas-fired facilities total just over 30,000 MW, which includes the 6,986 MW added to the system since 1998. Nuclear facilities contribute 4,310 MW, and hydropower another 14,116 MW. Geothermal, wind, waste to energy and solar total 6,050 MW.
- The overall efficiency of California's electric generation system has continued to improve, and the addition of new efficient combined-cycle power plants in the coming years will continue this trend.

- Intermediate load-following ('swing') capacity plays an important role in the system. Natural gas-fired power plants provide the major portion of the state's swing capacity to respond to variation in the availability of hydropower and imports.
- Some existing facilities have been displaced as a result of decisions to retire older facilities or to replace them with new natural gas combined-cycle units, driven in large part by the costs of upgrades that would be needed to comply with current air emission regulations.

Environmental Performance

This chapter examines the trends in the environmental performance of California's electric generation system from 1996 through 2002, assessing the environmental effects of the system on air, biological, and water resources. "Environmental performance" for energy systems consists of several factors: thermal efficiency; environmental discharges; environmental quality effects; and environmental efficiency.

A given power generation facility can cause varying levels of impacts to an air basin, watershed or ecosystem. Thermal efficiency, environmental efficiency and rates of environmental discharge result from changes in generation and pollution control technology, economics, changes in environmental regulation, and changes in scientific understandings of natural systems. The ***2003 Environmental Performance Report*** focuses on changes in thermal efficiency and emissions.

Lack of environmental data hinders the Energy Commission's ability to report fully on the environmental performance and trends of the state's electrical generation and transmission system. Environmental monitoring and assessment data tends to be collected and managed by varying regulatory agencies fulfilling specific statutory and regulatory obligations. This mosaic of disparate information does not form a full and complete picture of California's energy system environmental performance.

Air Quality

- **Air Emissions from Natural Gas-Fired Generation:** California's reliance on in-state generation from natural gas, the cleanest of the available fossil fuels, benefits the state's air quality. Statewide, combustion-fired electric generation comprises a relatively small portion of the NOx (3%) and PM10 (0.47%) inventories, and a slightly higher portion of the CO_2 (16%) inventory. Between 1996 and 2002, the generation emissions and emission percentages stayed relatively flat.
- **Future Air Emissions Reductions Will Be More Challenging:** The predominance of natural gas as the preferred fuel for thermal generation limits the easy opportunities for additional NOx, PM10, and CO_2 emission reductions that were achieved earlier by switching to natural gas. Further improvements in air emissions performance of the generation sector must come from technological advances in emissions control or by decreasing reliance on combustion-fired generation through reduced demand or increased use of non-fired electricity sources. Agency coordination and research will be critical components to timely and cost-effective advances.
- **Emissions Control Retrofit Rules Are Effective:** Implementation of the NOx emissions control retrofit rules for utility boilers over the last decade has resulted in 80 to 90 percent reductions in NOx emission rates per MWh from these facilities. Over 85 percent of California combustion-fired generation uses some form of NOx emission controls. Nearly 21,000 MW,

or 60 percent, use selective catalytic reduction (SCR) for NOx emission control. Deployment of additional retrofit emission control equipment will depend on ongoing cost reductions for equipment, dispatch of existing units, the attainment status and air quality management plan of the district, and possible regulatory changes.

- **Possible Emission Reductions from Combustion Turbines:** The California Air Resources Board has initiated a proceeding to develop a guidance document for emissions reductions from combustion turbines. This proceeding could realize emission rate improvements and emission reductions for some combustion turbine generation units. The development of these rules, and implementation by districts, may affect the availability and cost effectiveness of these existing combustion turbines, and could result in retrofit or retirement of some turbines.
- **Natural Gas Facilities Provide Key Swing Capacity in Meeting Varying Electricity Demands:** The recent merchant-owned capacity additions and former utility-owned fuel-fired boiler and combustion turbine facilities, with a capacity of about 23,100 MW, now operate as the swing or load-following units on a daily, seasonal, and emergency basis. These units tend to be dispatched to accommodate the swings in demand and availability of in-state hydro and imported sources. Generation from these facilities increased 145 percent between 1996 and 2001, with the main increases in 2000 and 2001 in response to limited hydro resources throughout the west. Improvements in the NOx emission rate per MWh, resulting primarily from retrofit of the steam boiler facilities, limited the increase in NOx emissions that accompanied this spike in generation to 41 percent above 1996 levels. In 2002, when generation from these units dropped almost 40 percent compared to 2001, total NOx emissions from these units was 25 percent below 1996 levels, and the emission rate per MWh was 50 percent below that of 1996.
- **Continuing Air Emissions Reductions Needed**: California needs continued air emission reductions from the generation sector. The state's air quality infrastructure can, and should, provide practical and innovative rules to address both existing and new generation sources, resulting in appropriate emission reduction contributions from the generation sector.
- **Emissions from Out-of-State Generation**: In general, imported power causes minimal air quality effects within California, except potentially near the Mexico border. Out-of-state generation appears to exhibit an improving NOx emission factor, possibly due to the increased use of natural gas. Despite NOx and CO2 emission rates being higher for out-of-state generation, significant differences in air quality settings make it difficult to predict how the plants might contribute to out-of-state air quality.

Biological Resources

- **Habitat Loss:** The 18 operational natural gas-fired power plants licensed by the CEC after 1996 caused the loss of 225 acres of habitat and produced generally minimal terrestrial biological resource impacts. Power generation development from 1996 through 2002 used approximately 3,900 total acres of land. Because California's most sensitive species tend to occupy small habitat ranges, energy development projects have the potential to cause impacts when built nearby. Use of previously disturbed lands for energy projects can minimize such effects.
- **Transmission and Pipeline Impacts:** California's 31,720 miles of electric transmission lines and 11,600 miles of natural gas pipeline rights-of-ways can contribute to habitat loss, fragmentation and degradation. Electric transmission lines can cause bird mortality from bird strikes

and electrocution. Electric transmission lines can cause wildfires; between 1996 and 2002, the number of wildfires from powerlines decreased from 284 to 181 annually. New transmission to improve system reliability and link new renewable generation resources to the grid may need to be mitigated to reduce the risks of increasing impacts to wildlife and habitats.

- **Once-Through Cooling Impacts**: Twenty-one natural gas and nuclear power plants totaling 23,883 MW are located on the coast or on estuaries and use hundreds of millions of gallons of water per day for once-through cooling. Impacts to marine and estuarine ecosystems from the entrainment and impingement of aquatic organisms can be significant and are an issue of concern. Recent repowering proposals at five coastal power plants included modern combustion turbines that meet current air emissions standards, but did not propose changes to once-through cooling water systems that would substantially reduce impacts to aquatic organisms.
- **Impacts from Hydropower**: Salmon or steelhead habitat is found at hydropower facilities in the Sacramento River basin, the San Joaquin River basin and on the North Coast. Very few California hydropower projects have adequate, as currently defined, fish passage for migrating salmon and steelhead. Hydropower impacts to salmon, steelhead, native trout and other species continue to be significant. Thirty seven percent (5,000 MW) of California's hydropower system will be relicensed by the Federal Energy Regulatory Commission (FERC) between 2000 and 2015, presenting opportunities to address and mitigate impacts to salmon, trout and other aquatic species.
- **Nitrogen Deposition**: Nitrogen deposition from new power plants and repower projects has potential cumulative impacts if the power plant is within the vicinity of nitrogen sensitive habitats, such as serpentine soil and desert communities. Potential nitrogen deposition impacts from new power plant proposals are emerging as an issue of concern.
- **Impacts from Wind Power:** Renewable energy from wind power will play a large role in meeting California's new Renewable Portfolio Standard. Bird mortality from strikes with turbine blades continues to be the primary biological resources issue concerning wind energy. Based on an estimate of 15,000 operational wind turbines in 2001, an estimated 488 raptors are killed annually by turbines, nearly all (96%) in California.
- **Wildlife-Friendly Renewable Energy Production:** Few renewable energy facilities have been built since 1996, but a substantial increase in renewable generation will result from the Renewable Portfolio Standard. Building integrated solar photovoltaic and biogas-fired electric generators at landfills and sewage-treatment plants have the least risk of impacting biological resources. Other renewable energy types, such as in-forest fuels, could have wildlife-friendly benefits if biological resource protections were integrated into the planning.

Water Resources

Water Supply

- Competition for the state's limited fresh water supply is increasing and in some years contractual obligations to supply water cannot be met.
- Water use for power plant cooling can cause significant impacts to local water supplies, but tends to be a relatively small use at the aggregate state level.
- Since 1996, an increasing number of new power plants have been sited in areas with limited fresh water supplies. More than 5,700 MW of new power has been constructed or is being

licensed within southern California. As a result, use of fresh water for power plant cooling is increasing.

- Degraded surface and groundwater can be re-used for power plant cooling. When sufficient quantities are available, reclaimed water is a commercially viable cooling medium. Of the 4,516 MW of new generation capacity brought on-line in California between 1996 and the end of 2002 for which Energy Commission staff has detailed water use information, more than 1,400 MW (31%) is cooled using recycled water.
- Alternative cooling options, such as dry cooling, are available, commercially viable, and can reduce or eliminate the need for fresh water. Two projects using dry or air cooling became operational in 1996 and 2001. A third project using dry cooling in San Diego County has been permitted by the Energy Commission.
- Actual water use data for power generation is not readily available. Lack of consistent and complete data significantly hampers the Energy Commission's ability to report on water use trends.

Water Quality

- Water quality impacts to surface water bodies, groundwater and land from waste water discharge are being increasingly controlled through use of technologies such as zero liquid discharge systems. Of the 4,516 MW of new capacity brought online between 1996 and the end of 2002 for which Energy Commission staff has detailed water use information, 12 percent use zero liquid discharge. More than 35 percent of the projects under licensing review or under construction will use this technology.
- Continued use of once-through cooling at existing and repowered power plants perpetuates impacts to aquatic resources in coastal zone, bays and estuaries. While no power plants using once-through cooling have been proposed for new California coastal sites in the last two decades, proposals to repower generation units at these sites have not included proposals to change cooling system infrastructure.
- Hydroelectric facilities can cause permanent alterations to stream flows, raise water temperatures, alter dissolved oxygen and nitrogen levels, and cause changes to the aquatic environment. As of 2003, only a small portion of California's hydropower system meets current state water quality standards**.** Only six of 119 projects licensed by the Federal Energy Regulatory Commission have Section 401 Clean Water Act certification from the State Water Resources Control Board, and three more are nearly complete. These nine projects total 275 MW, which is about two percent of California's hydroelectric generating capacity.

Societal Effects

Land Use Compatibility

- Forty percent of Energy Commission siting cases from 1996 through 2002 required a general plan amendment or zoning change, or other local actions like parcel map changes or Williamson Act cancellations, although it is unclear if this is typical of other major industrial development.

- In rapidly growing urban areas, energy infrastructure development and repowering often occurs very close to sensitive community resources such as new residential areas, schools, and recreation areas, which can lead to intense controversy and delay the facility siting process.
- Existing coastal power plants are generally located in areas that have experienced significant development and residential growth, and the repowering of those projects has caused and is likely to continue to cause local debate and controversy.
- Local and regional land use and development planning efforts seldom designate sites or corridors for energy facilities such as electric power plants and transmission lines, and energy facility proponents are seldom involved in these long range efforts.

Socioeconomic Resources

- The 17 power plants permitted by the Energy Commission since 1996 that were on-line by December 31, 2002 added 4,418 MW in generation capacity, and have resulted in approximately 3,900 peak construction jobs, 125 operations jobs, capital costs of approximately $1.5 billion, and, for fiscal year 2002-2003, approximately $23 million in property taxes.
- The ***2001 Environmental Performance Report*** estimated a 10-to-1 ratio of direct peak employment construction jobs to direct operation jobs for power plants. Data from the permitting of the non-emergency power plants approved by the Energy Commission since 1996 that were online by December 31, 2002, show this ratio was 25-to-1. This increase may be a result of faster construction cycles to meet the demands of the California energy crisis.
- Steam boiler plants typically have 40 to 50 maintenance and operation employees. The gas-fired simple-cycle and combined-cycle power plants that are now being built have a range from approximately 2 to 24 maintenance and operational workers.
- State law prevents public agencies such as the Energy Commission from imposing fees or other financial mitigation for impacts on school facilities. The school impact fee that can be levied by a school district usually ranges from $2,000 to $6,000 per power plant project. Municipal utility districts are exempt from these fees.
- Starting January 2003, the Board of Equalization now assesses all privately owned electric generation facilities over 50 MW, including facilities divested by the public utilities that had been assessed by counties after deregulation. These facilities will be assessed at fair market value and revenues will be distributed to those jurisdictions located in the tax rate area where the power plant is located.

Environmental Justice

- The Energy Commission and the California Department of Transportation were the first state agencies to include environmental justice concerns and demographic information in their environmental impact analyses.
- The Commission's approach to environmental justice emphasizes local mitigation and seeks to reduce environmental impacts that could affect local populations to less than significant levels. Of the projects identified as having greater than fifty-percent minority populations within a six-mile radius, appropriate mitigation has been identified to reduce significant impacts to less than significant levels, thereby removing any potential for an environmental justice issue (high and adverse disproportionate impact associated with a proposed project). Therefore, the Commission has never considered denial of a project based on the findings of an environmental justice analysis.

- From 1979 through 1995, 14.3 percent of power plant applications submitted to the Commission were sited in communities where minorities comprised greater than 50 percent of the population.
- F·rom 1996 through 2002, 50 percent of power plant applications submitted to the Commission were sited in communities where minorities comprised greater than 50 percent of the population.
- As of Census 2000, minorities comprise the majority of the population in the state so environmental justice will be a consideration in many future power plant siting cases.
- Power plants proposed in densely populated urban areas are often sited where residential land uses encroach on older industrial areas.
- Community involvement related to environmental justice during siting cases has primarily occurred in proposed power plant cases in the large urban areas of Los Angeles and San Francisco.

Conclusions

The ***2001 Environmental Performance Report*** concluded that the collective impacts of power plant facilities have declined over time due to improvements in thermal efficiency, fuel switching from oil to natural gas, emission control technology advances, the development of renewable generation resources, and the adoption of environmental laws and regulations. While the trend in improved environmental efficiency – fewer environmental impacts per unit of energy produced – was positive, significant concerns with impacts to aquatic resources from hydropower generation and once-through cooling continued.

This ***2003 Environmental Performance Report*** shows that this trend toward improved environmental performance of the electric generating system has continued since deregulation was enacted into law in 1996. Despite the energy crisis of 2000 and 2001, which has had major financial impact on all aspects of the energy market in California, the general trend toward improved environmental performance does not appear to have been significantly affected for good or ill by the deregulation of the system. This appears primarily to result from the fact that the basic laws and regulations that serve to protect the environment and public health were not changed by market deregulation and the utilities' divestiture of their major generation assets. With these protections in place and technological advances in efficient generating capacity and environmental controls, the addition of new generating capacity over the coming decade will serve to further improve the environmental performance of the system as a whole.

While general trends are positive, significant regional, generation sector and environmental media differences in energy system impacts remain. Decreases in air emissions from the electricity generation sector are impressive and can be attributed to successful applications of Clean Air Act regulations by State of California regulators at the Air Resources Board and local air quality management districts. Air quality levels continue to be poor throughout the state, and the relative contributions of power plant emissions to local air basin inventories and air quality varies regionally.

More complex are the tradeoffs between impacts to air, water and land. Impacts to aquatic ecosystems continue to be the most difficult to understand scientifically, and the most difficult to alleviate. For example, hydropower does not contribute to air quality impacts, but aquatic ecosystems at a watershed scale have been severely degraded by hydropower development and operation. Repowering a large natural gas-fired power plant at one of California's 21 coastal energy complexes means that new generation units with high thermal efficiency and very low emissions can be installed. Existing infrastructure can also be re-used, which minimizes new impacts to terrestrial habitats from new foundations, roads and transmission lines. But the tradeoff can be continuing impacts to sensitive estuaries, bays and marine areas.

Wind energy is a resource of promise that will be expanded in California due to the Renewables Portfolio Standard. It is "clean" in that it emits nothing to the air, yet continuing impacts to hawks and eagles remain an issue of concern. Electric transmission lines enable the effective transfer of electricity from areas of generation to areas of demand, which means that a wide array of energy resources can be brought to large urban areas from distant parts of the state and western North America. But the full environmental effect of transmission lines on birds, desert ecosystems and forested regions has yet to be documented, and is an issue of concern.

Differences in regulatory systems contribute to these varying impacts to differing parts of the natural environment. Poor air quality impacts human health, so air emissions are closely monitored, well understood, and tightly regulated by an interlocking system of federal, state and local authorities. The impacts to water quality and aquatic ecology from power plants of all types typically tend not to directly affect human health. This may be why impacts to river fisheries and coastal bays are more difficult to regulate and mitigate. The regulatory system for water quality and aquatic species is fragmented across multiple laws (Clean Water Act, Porter-Cologne, Federal Power Act, California Fish and Game Code, Warren Alquist and California Coastal Act, for example) and multiple state and federal jurisdictions. Differing agencies have differing priorities and statutory mandates.

Energy imported from outside of California's borders means less impact to California's natural resources and positive effects for the economies of other states and countries. California utilities own more than 6,200 MW throughout the west, primarily coal-fired generation. Coal is a low cost and reliable energy resource, but emits higher levels of NOx, particulate matter and SOx than in-state natural gas-fired generation. Air quality in neighboring states tends to be better, so the net impact to air quality is less than if the plants were located in California. This scenario does not hold for Mexico. Poor air quality in the border region of Mexico raises issues of varying international regulatory standards, especially for power plants built to serve California energy markets.

Such examples of tradeoffs between regions, between impacts to air versus land versus water, or between impacts to a Southern California air basin compared to a Northern California watershed, are extremely difficult to assess given current structures of governance and regulation. The Energy Commission cannot yet report on cumulative energy effects, nor assess the relative contributions of electricity generation and transmission, to different air basins, watersheds and bioregions. Two root causes are a lack of systematic environmental monitoring data and compilation across all statutes related to the energy sector, and the lack of a scientific method to assess the variation in environmental effects across technology sectors and environmental media. As reported in this ***2003 Environmental Performance Report***, lack of current, sufficient scientific environmental data hampers the Energy Commission's ability to fulfill its statutory responsibility to report to the Legislature, Governor and public on the environmental performance of all aspects of California's electricity generation and transmission system. Life cycle impact analytic methods may offer promise to better understand the full systems-level effects of the state's energy generation and transmission system. Such methods require large amounts of environmental data however, and are complex when an energy system as vast as California's is analyzed.

One important environmental issue facing California is not addressed in the ***2003 Environmental Performance Report***. Global climate change will create a series of effects on California climate and hydrology that will in turn impact the state's wide array of bioregions and ecosystems. Many of the state's habitats and ecosystems are small and already stressed. The scale of climate change effects will be pervasive, and may alter ecological balances in specific ecosystems and bioregions. Specific electricity generation and transmission effects on local environmental systems may in turn become more acute. Electricity generation contributes to climate change, and will be affected by it as well. While this may be the single greatest environmental issue before the state, analysis of these climate change issues was beyond the scope of this report.

In sum, the Energy Commission staff believes, based on the available data, that the general environmental performance trend is positive. The environmental footprint of the energy system required to supply the state's people and economy is relatively small compared to that for other parts of the nation and the world. Discrepancies in impacts to various parts of the natural environment remain large though. The Energy Commission has direct jurisdiction over a relatively small portion of the state's electrical generation system. As cooperative relationships are formed with other state and federal agencies and a more robust collective understanding of the state's energy system emerges, the Energy Commission will be able to more capably report on the complete extent of the environmental performance of California's electrical generation and transmission systems.

Environmental Performance Report
Chapter 1
Introduction

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Chapter 1
Introduction

This report assesses the environmental performance and related impacts of California's electric generation facilities, as required under Public Resources Code section 25503(b). This section requires the Energy Commission, as part of the Integrated Energy Policy Report, to report to the Governor and the Legislature on the current status of the following:

- the environmental performance of California's electric generating facilities, including generation efficiency and air pollution control technologies;
- the extent to which recent resource additions have, and expected resource additions are expected to, reduce the operation of existing electric generation facilities, and the resulting environmental consequences; and
- the geographic distribution of environmental impacts from electric generating facilities, including impacts to air quality, water resources and wildlife habitat, and the geographic distribution of related socioeconomic benefits and drawbacks.

This staff draft of the ***2003 Environmental Performance Report*** is intended to provide the factual basis for possible policy recommendations to the Governor and Legislature on measures that may be needed to improve the environmental performance of California's power generation and transmission system. This report portrays current environmental conditions and performance trends and identifies key issues. Such recommendations will be incorporated into the final ***Integrated Energy Policy Report*** and related reports that will be considered for adoption by the Energy Commission this fall.

The ***2001 Environmental Performance Report***, which provided California's first state-level review of the environmental and societal effects of our energy system, assessed broad environmental and socioeconomic trends from the 1950s to the mid-1990s, prior to deregulation of the electric system in 1996. This 2003 report focuses on the performance of the system since deregulation was enacted. The Energy Commission and Legislature are interested in understanding how the environmental performance of the electric generation system has changed since deregulation.

The 2003 report expands the environmental assessment of the state's electric generation system to include the electric transmission system and the natural gas supply pipeline system. These systems are integral features of California's power generation infrastructure, but their "environmental footprint" is not well understood. The 2003 report also continues the environmental assessment of all energy generation sectors, including fossil fuel, nuclear, renewable resources such as wind and small hydro, and large hydro. Because energy imports can provide as much as 30 percent of the electricity used in California, this report contains an initial assessment of energy imports and associated environmental issues.

Chapter 2 sets the stage by describing the historical and geographical development of the diverse facilities that make up California's electric generation system. This chapter also describes the operation of the electric system, and addresses the question of possible displacement of existing resources through the recent addition of new generation facilities. The energy crisis of 2000 and 2001 is briefly reviewed, including a short assessment of the limited environmental effects of the crisis.

Chapter 3 describes the impacts of California's electric system on air quality and biological, water and cultural resources. It focuses on the effects of the natural gas fired-portion of the power generation system because environmental data for this sector are more readily available than for renewables, large hydro and imports. The air section assesses emissions trends for oxides of nitrogen (NOx), particulate matter, and Carbon dioxide (CO_2) at a statewide level. The biology section examines impacts to upland wildlife habitats and freshwater and marine aquatic habitats from new and existing power plants, and from the electric and natural gas transmission systems. The water section assesses impacts to water quality and water supply for power plant operations. The cultural resources section provides an initial overview of cultural resource issues, but this report does not examine these issues in detail.

Chapter 4 discusses societal effects of the state's generation system. This chapter assesses the land use compatibility issues that arise from electric generation facilities and the socioeconomic effects of these facilities. The chapter also reviews the Energy Commission's approach to environmental justice in power plant siting cases.

The conclusions are presented in Chapter 5.

References, a glossary, and acronyms are found at the end of this report. Appendices provide supporting data for Chapters 3 and 4. All appendix materials are found only on the CD-ROM version of this report or on the Energy Commission's Web Site at <www.energy.ca.gov>.

Environmental Performance Report
Chapter 2
Overview of the West Coast Electric System

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Chapter 2
Overview of the West Coast Electric System

Summary of Findings

- California's electric capacity and generation is provided by a diverse set of electric generation facilities located in California and out of state. The importance of natural gas-fired capacity has increased in California in recent decades, and new capacity additions in California are primarily natural gas.
- The overall efficiency of California's electric generation system has improved, and the addition of new combined-cycle power plants in the coming years will continue this trend.
- Intermediate load-following ('swing') capacity plays an important role in the system, providing the capacity needed for the system to respond to swings in availability of hydro power and imports. Natural gas-fired power plants provide the major portion the state's swing capacity.
- Displacement of existing electric generation to date has primarily occurred through decisions to retire old facilities or to replace them with new natural gas combined-cycle units. Such decisions have been driven in large part by the costs associated with upgrades that would be needed for some facilities to comply with current air emission regulations.

Historical Development of the California Generation System

California's electric system was developed over the past century by investor-owned utilities, publicly owned utilities (federal, state and municipal), irrigation districts, and independent power producers. These electricity providers have built power plants, transmission lines, and distribution systems that cover the state, linking sources of electric energy to end users. California's system is also part of the interconnected western grid, which includes most of the territory of the eleven western states as well as portions of British Columbia, Alberta and Baja California.

The development of California's electric system has gone through distinct stages since its birth at the end of the 19^{th} century (**Figure II-1**). Early in the 20^{th} century, abundant hydrological resources were the main sources of electricity. Hydroelectric development has continued in all decades throughout the century, peaking in the 1960s. Substantial hydroelectric pumped storage capacity was added from the late 1960s to the early 1980s. Today, most of the cost-effective sites for hydropower projects have already been developed.

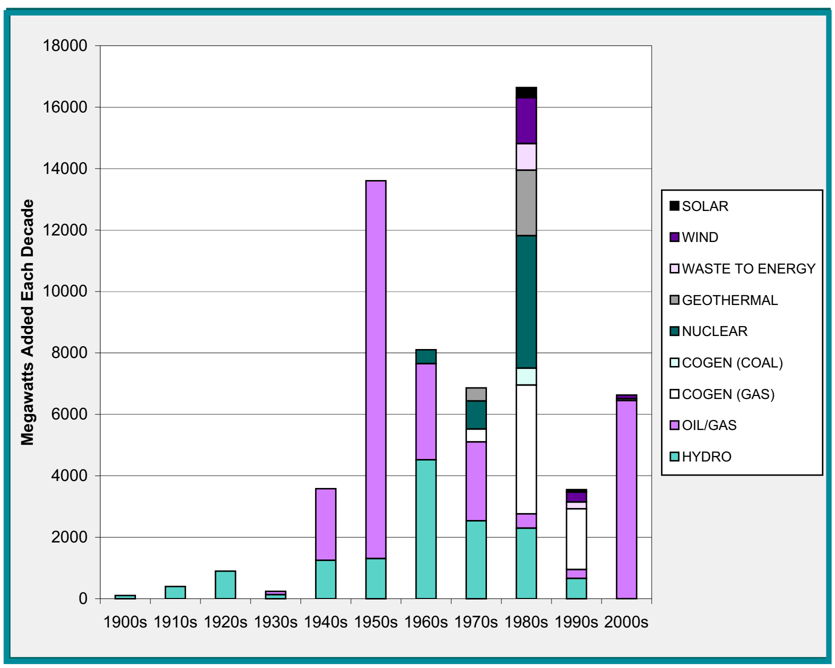
Oil-fired power plant development began in the late 1930s and peaked in the 1950s. Since the 1970s, fossil fuel fired generation in California has shifted from oil to natural gas. Most existing oil-fired facilities converted to natural gas, though some maintained the capacity to use oil as a backup fuel. Most new fossil fuel-fired plants built in California since the 1970s have used natural gas.

From the late 1960s to the 1980s, four nuclear power plants were added to California's utility system, though two have since been retired.

Many of the power plants developed in the state during the 1980s and 1990s were cogeneration systems fueled mostly by natural gas, though a few use coal. Starting in the 1970s, renewable resources other than hydropower were added to the generation mix, including geothermal, wind, waste, and solar energy.

From 1998 to May 2003, 37 electric generation projects totaling more than 13,800 megawatts (MW), have been licensed by the California Energy Commission. As of June 1, 2003, 22 of these licensed facilities have been built and are in commercial operation, with a combined capacity of

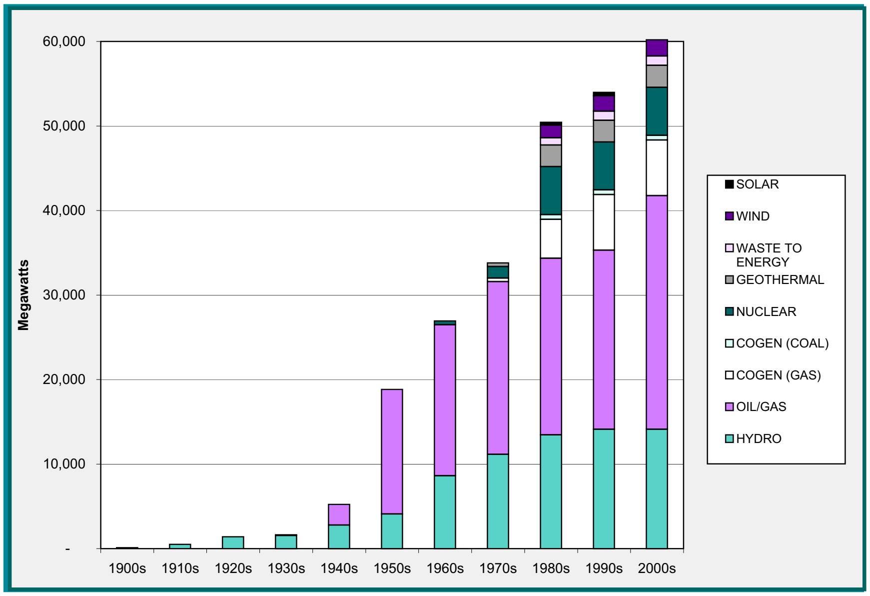
Figure II-1
Generating Capacity Additions in California by Decade and Primary Energy Type



6,986 MW. Three more are expected to be in commercial operation by July 31, 2003, representing another 1,100 MW addition to capacity. Another 1,718 MW of new generation capacity has been added from local permitting of projects outside the Commission's jurisdiction. As of June 2003, 14 additional projects with a combined capacity of more than 8,590 MW are under review by the Commission.

Figure II-2 shows the cumulative capacity for different types of power plants available at the end of each decade in California since the start of the 20th century.

Figure II-2
Cumulative Generating Capacity in Calfiornia
by Decade and Primary Energy Type



Finding: California's electric capacity and generation is provided by a diverse set of electric generation facilities located in California and out of state. The importance of natural gas-fired capacity has increased in California in recent decades, and new capacity additions in California are primarily natural gas.

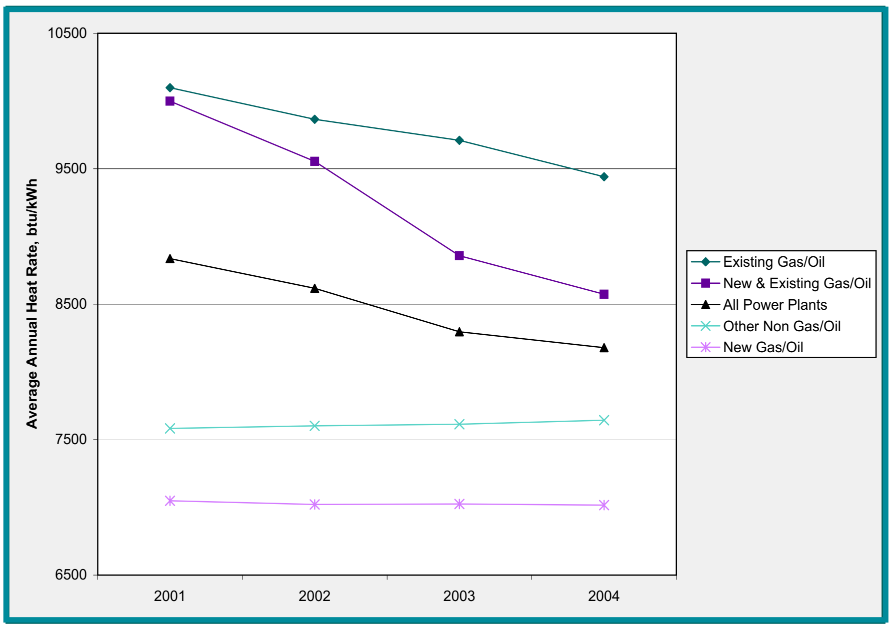
Generation System Efficiency Has Improved

In California, the generation system has become more efficient over the decades, with less fuel or energy needed to produce a unit of electricity. Power plants convert the chemical, nuclear, kinetic, heat, or radiant energy in their fuel sources to electric energy. Different types of plants vary greatly in how efficiently they convert their primary energy source into electric energy. Within each type of plant, efficiency also varies due to specific differences in location, plant design, and mechanical conditions of the equipment. Generally, the more efficiently a power plant converts its primary energy into electric energy the better. Higher efficiency, though, is often offset by higher costs, especially for capital outlays.

Efficiency is measured as a 'heat rate', the amount of energy content need to generate one kilowatt hour of electricity. **Figure II-3** shows relative efficiencies of power plant groupings supplying California and the West. The total system heat rate in 2002 was about 8,600 Btus, per kilowatt-hour (Btu/kWh). This estimate includes all generating sources, even those that consume no fuel—solar, wind, geothermal, hydroelectric. The average heat rate for plants that burn natural gas was just under 9,600 Btu/kWh in 2002.

For a given level of demand, overall system efficiency can be improved by adding more generation resources that do not consume fuel, or by adding sources that consume fuels more efficiently, such as the highly efficient natural gas-fired power plants that have come on-line in recent years. These plants use jet engine-like gas turbines to generate electricity directly, and then capture the heat energy in the exhaust to power a steam cycle that generates more electricity. As shown in **Figure II-3**, these combined-cycle power plants (labeled 'New Gas') have heat rates of about 7,000 Btu/kWh. The decline in average heat rate from 2001 to 2004 for all power plants shown in **Figure II-3** reflects the expected addition of about 10,000 MW of new combined cycle plants, plus a few hundred megawatts of wind and geothermal resources. Overall system efficiency could improve by 2004 to about 8,100 Btu/kWh.

Figure II-3:
Illustrative Future California
Generating System Efficiency



The efficiency of the state's electric system varies from hour to hour, with efficiency generally better when demand is lower and worse when it is higher. This pattern results from the economic dispatch of generating resources to meet increasing loads. The least expensive (and usually most efficient) resources typically are turned on before the more expensive (and usually least efficient) resources. The dispatch of generating resources is discussed in more detail later in this chapter.

At times when demand for electricity is at a peak, most available resources will be operating to help serve load. The least efficient of the plants serving load could have a heat rate as high as 20,000 Btu/KWh, but these plants would be used very few hours of the year.

> **Finding:** The overall efficiency of California's electric generation system has improved, and the addition of new combined-cycle power plants in the coming years will continue this trend.

Operating Modes of Power Plants

Because electric demand varies significantly through the day, from day to day within the week, and through the different seasons of the year, a mix of generation facilities is needed to serve demand. Power plants in California and throughout the West operate in the following modes:

- baseload duty cycle
- load-following or intermediate duty cycle
- intermittent duty cycle
- peaking duty cycle

Some power plants operate in baseload duty cycle. Once such plants start up, they operate continuously until shut down for maintenance or refueling. Nuclear, coal-fired, and geothermal power plants fit into this category. Cogeneration power plants, where power production is secondary to a continuous thermal industrial process, such as oil refining, also operate as baseload facilities. Some hydroelectric facilities with continuous water flows operate as baseload plants (*e.g.*, on the Columbia River and on some aqueducts).

Load-following or intermediate plants are those that can regularly ramp up energy production when demand increases. Individual plants may be called on to operate at maximum capacity, with other plants brought online as loads increase. In California, most of these plants are gas-fired or large hydro with flexible dispatch.

Intermittent power plants, such as wind, solar, and most small hydroelectric facilities, operate as much as they can whenever their energy supply is available.

Peaking plants are those facilities that can be called on to meet peak demand for a few hours at a time on short notice. Combustion turbines and some hydroelectric plants that can dispatch some or all their capacity when needed fit this category. Pumped storage plants can also generate electricity in peaking mode. Peakers are dispatched when the supply-demand balance is tight, generally when the level of demand reaches its maximum.

Electric Generation System Operation

Supply/Demand Balance

Only a fraction of total capacity of the system is needed to meet typical demand in the state through most of the year. Total electricity demand in California in 2002 was almost 275,000 gigawatt-hours (GWh), or an average of approximately 31,000 MW output throughout the year. This compares to a total installed capacity of 55,800 MW within California, plus 6,200 MW of capacity located in Arizona, Nevada, Utah and New Mexico that is owned by California utilities. **Figure II-4** shows the mixture of resources that have provided electric energy to California from 1983 to 2002. (Generation from California-owned facilities located outside the state is included as in-state generation rather than imports.) The peak daily demand also varies significantly through the year and between weekdays and weekends, as shown in **Figure II-5**.

Figure II-4
Sources of California Electrical Energy Consumption

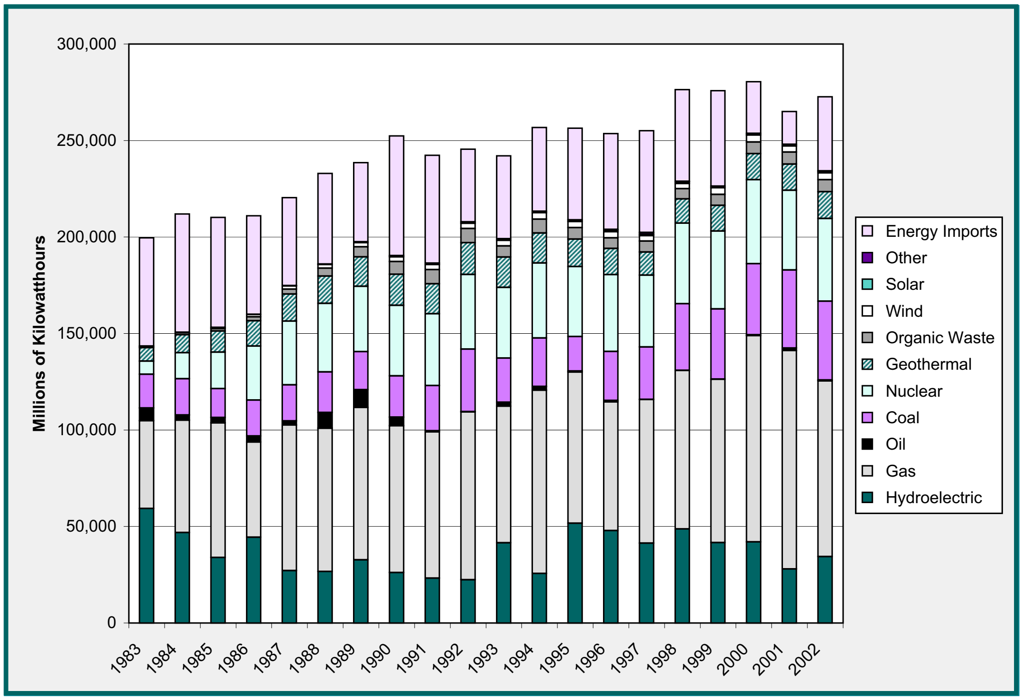
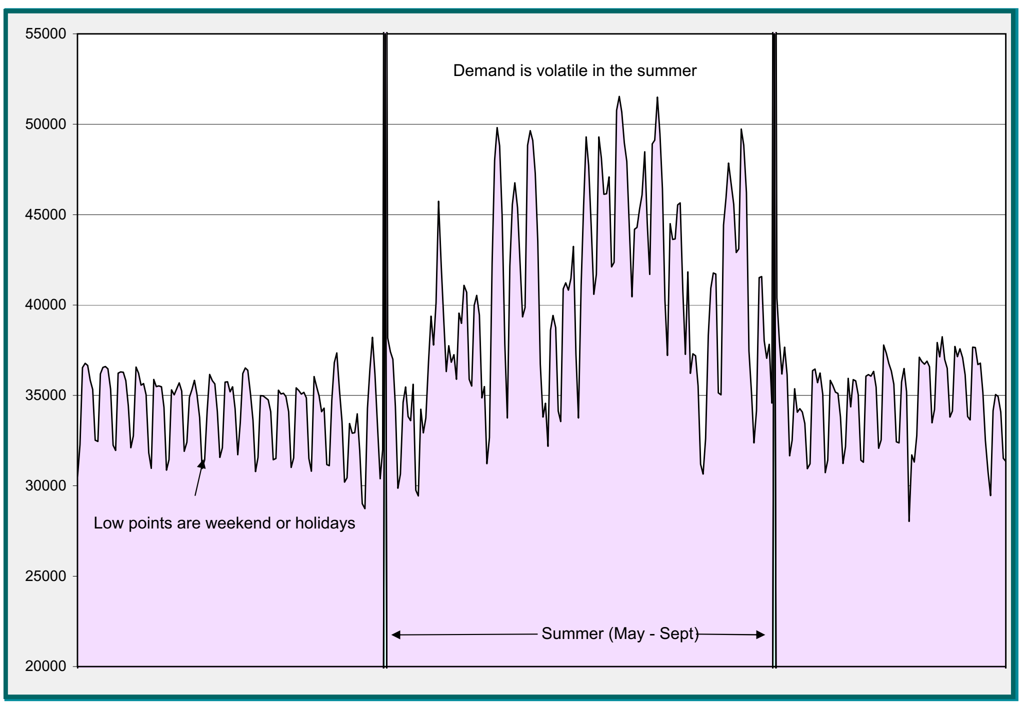
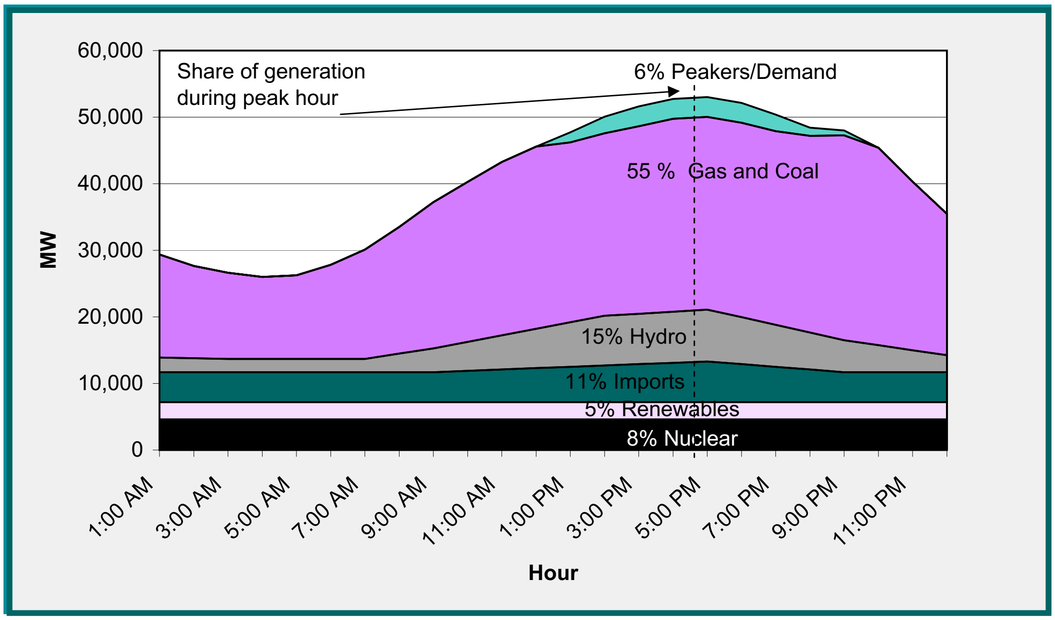


Figure II-5:
Patterns of Daily Peak demand



The full available capacity of the system needs to be called upon only to meet periods of peak demand, which in California typically falls on hot summer afternoons. **Figure II-6** illustrates a typical electricity supply and demand profile for a hot California summer day. This figure demonstrates the importance of the full range of generation facilities, including peaking power plants, to provide peak capacity resources for a short amount of time during high demand. In addition, California has developed demand response and load management programs that help reduce peak demand. These programs serve as supply resources for the state, but are not included in **Figure II-6**, which shows a typical hot summer day supply and demand profile after these programs have reduced the peak demand.

Figure II-6
The Electricity Supply and Demand Profile for a Typical Hot Summer Day



Energy and Power

The distinction between energy and power is important to consider when evaluating the environmental performance of the electric generation system in California. In terms of electric system performance and operation, energy is discussed in terms of the generation or consumption of the system, typically measured in kWh at the household level, and MWh or GWh at larger scales. Power is discussed in terms of the capacity of the system or the peak supply or demand, and is typically measured in MW. The relation between these two concepts and measures is relatively simple – the energy generated over a period of time can be calculated by multiplying the power level in question by the period of time. For example, a power plant operating at its full capacity of 500 MW for one hour generates 500 MWh of energy; operated at that power level for 24 hours, it generates 12,000 MWh.

The performance of the electric system in California relates in different ways to both the energy and power requirements. For example, the system's ability to meet peak demand is primarily power-related, relating to the overall capacity of the state's generation system, the ability of the transmission system to distribute the power to where it is needed, and the ability to reduce peak demand. Many environmental and social effects relating to electricity generation relate to these power needs based on the need to construct new power plants.

Other environmental outcomes relate more to the need for energy from the system. For example, the total air emissions from a power plant will depend in large part on the amount of energy it generates, since a given power plant typically emits a certain amount of pollution per MWh generated. Knowing the frequency of operation is essential for understanding the overall social and environmental effects of a power plant. The distinction is not always clear cut, though, since some of these 'energy-based' environmental effects can be of concern on a short-term basis that might not be noticeable if evaluated on an annual basis.

Throughout this report, the operation and effects of the electric system will be discussed both in terms of energy and power. Keeping the distinction in mind will help the reader better understand this assessment of the performance of the system.

Western System Resource Sharing

Transmission lines allow utility systems to be interconnected and share generating resources. Interconnections improve reliability for delivering energy. Regional sharing of generation resources is more favorable and mutually beneficial when strong differences exist for both loads and resources. Load diversity between regions exists when a region's peak demand period is during another region's low demand period. Similarly, resource diversity exists by virtue of geographic differences. For example, some regions have large coal deposits while others have large hydroelectric resources. Regional resource sharing reduces potential risks that affect one type of resource, such as drought or high natural gas prices. With better interconnections, fewer power plants need to be built overall, with some corresponding cost savings. Corresponding environmental effects can be avoided, reduced, or diversified.

Figure II-7:
Map of Western Systems Coordinating Council Reporting Areas

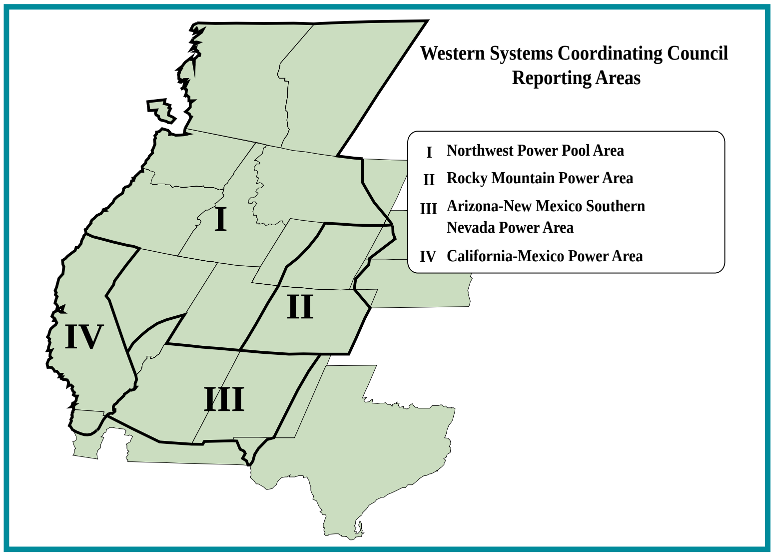
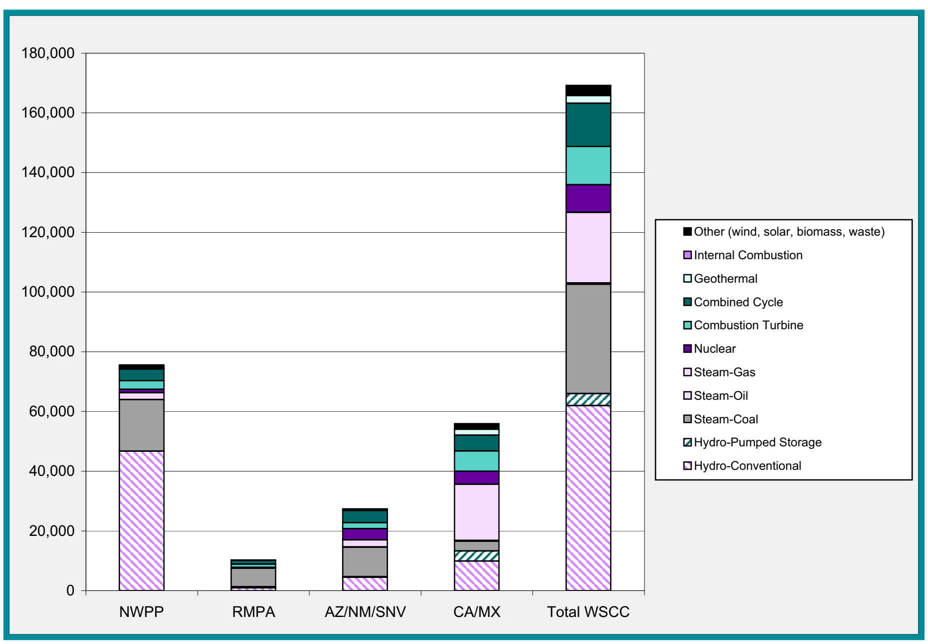


Figure II-7 depicts the sub-areas of the western system as defined by the Western Electricity Coordinating Council. **Figure II-8** shows the amount of power plant capacity and the mix of resource types for each of these sub-areas, as of January 2002. In the Northwest Power Pool Area, where peak electricity demand occurs during winter evenings, hydroelectric resources dominate, with coal being the second largest portion of supply. Coal-fired generation dominates the Rocky Mountain Power Pool Area. The Arizona-New Mexico-Southern Nevada Power Area, with electricity demand patterns similar to California, has a more diversified mix of generation, though still dominated by coal, but with large portions of hydroelectric, nuclear and natural gas-fired resources.

Figure II-8 :
Existing WECC Generation by Sub-Area (Megawatts)



The California-Mexico Power Area has a very diversified mix of generating resources, dominated by gas-fired capacity with significant amounts of hydroelectric, coal, nuclear and geothermal capacity.

Given this regional diversity in patterns of demand and types of electricity resources, an active bulk power purchase and exchange market has developed since the 1960s among the utilities of the West, facilitated by regional high-voltage transmission line interconnections. Utilities based in one state participated in the development of power plants in other states from which power can be exported to their customers. For example, coal-fired power plants in the Southwest are owned in part by Los Angeles Department of Water and Power, Southern California Edison, and various municipal utilities. Today, California utilities rely on electricity imports to supply a significant part of their customers' demand, especially to meet peak demand on hot summer afternoons. Other sub-areas of the West also rely on imported power. For example, the Northwest Power Pool Area often relies on exports from California to meet demand on cold winter evenings.

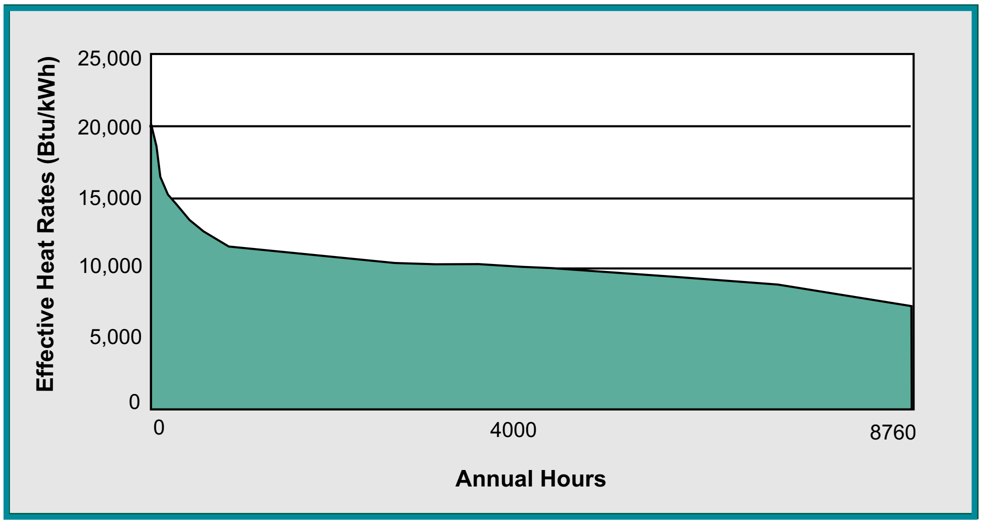
Dispatch of Electric Generating Resources

The mix of sources of electricity used to meet annual demand in California is governed by the hour-to-hour dispatch of generating resources by the operators of the different control areas. In the West Coast interconnected electric generation and transmission system, power plants are dispatched to meet the demand for electricity in a 'merit order'. The merit order reflects each unit's relative variable costs of production, with hydro generation, as a rule, being least expensive, followed by nuclear and coal, then natural gas. (Renewable resources and cogeneration are generally 'must-take', and thus dispatched out of merit order; see below.) Coal- and gas-fired resources are generally dispatched according to their heat rates, with the least efficient coal plants being more costly than efficient gas-fired combined cycles. Units with higher heat rates have higher positions in the merit order and are used less frequently. Coal facilities are dispatched prior to gas-fired plants due to relative fuel costs. Coal has a higher heat rate than natural gas, but is sufficiently less expensive than natural gas so as to result in a lower production cost. Transmission losses and costs are also factored into the merit order. A power plant that has lower transmission losses or financial costs associated with the delivery of its generation (due to proximity to load) will be lower on the merit order than another plant with the same heat rate or perhaps even one with a slightly lower heat rate.

Hydropower resources typically have a favorable position in the merit order ranking due to their relatively low variable costs of production. This is tempered by the fact that these resources are typically located distant from load centers, which tends to increase transmission losses. Hydro facilities often also have a variety of operational constraints relating both to other uses for the overall hydro system, such as water supply, flood control, and environmental requirements, and to the amount of precipitation and water storage, which sets an absolute limit on a given year's potential supply of hydro-generated electricity.

Figure II-9 shows the marginal heat rate (heat rate of the last unit needed to be dispatched to serve load that hour) for the hours of a typical year. The least efficient units are used for relatively few hours of the year, as shown at the left end of the graph, corresponding to times of peak demand. For most of the hours of the year, the system marginal heat rate fluctuates within a fairly narrow range, as shown by the relatively flat slope of the curve. Many power plants with similar heat rates are dispatched to meet moderate demand levels.

Figure II-9:
Generation Duration Curve



The actual merit order of power plants available to generate power will change daily. When a power plant is shut down for refueling, scheduled maintenance, or forced outage, it cannot be dispatched to serve load that hour and the next most expensive resource will take its place in the merit order ranking. Such shifts typically make little difference to overall system efficiency because these substitutions typically occur between plants with very similar efficiencies. However, such substitutions can make marked differences in environmental effects that are necessarily geographic.

The dispatch of power plants is constrained by numerous physical, contractual and economic factors that limit or preclude changes in the output of existing plants despite the availability of cheaper energy. These constraints, termed 'must-run' and 'must take,' can place limits on the actual benefits realized by adding new plants.

'Must-run' constraints can be the result of either the location of a power plant or its operating characteristics. The location of a plant may make it an indispensable provider of reactive power, necessary to maintain the stability of the electric system. Location in a transmission-constrained area may also require that the plant operate in order to guard against the possibility that the failure of another plant or a transmission line could cause a collapse of the system. In addition, some power plants, such as nuclear facilities, run-of-river hydro facilities, and 'slow-start' steam turbines, cannot reduce output because of the physical and economic costs of doing so.

'Must-take' plants are those whose output must be purchased due to contractual obligation (*e.g.*, qualifying facilities), because the output of the plant cannot be controlled short of a complete shutdown (wind and solar facilities), or due to physical or environmental constraints (run-of-river hydro).

This system of constrained merit order dispatch is intended to ensure that electric supply and demand remain balanced throughout the year, including on days of peak demand, while attempting to minimize the overall costs of operating the system. The year-to-year variation in the availability of hydro resources due to changes in precipitation in California and the Pacific Northwest greatly influences the mix of resources called upon to meet California's demand during the year.

In recent years, in-state hydropower has provided as little as 10 percent and as much as 20 percent of the state's total electricity. Imports into California also varied during the 1990s from 15 to 25 percent of California's electricity consumption, in part due to changes in availability of hydropower resources in the Pacific Northwest. The Western power system has been designed to accommodate this variability. When precipitation runoff is bountiful, hydroelectric generation is used and other generating plants, mostly gas-fired, are idled. When hydroelectric energy generation is low, intermediate generating plants will make up the difference.

The variability of hydro resources has important implications for the overall performance of the state's generating system. Typically, low hydropower production is offset by a combination of increased imports, if available, and increased generation by in-state natural gas power plants. While eight new large combined-cycle power plants have come online in recent years, the bulk of the natural gas capacity in the state remains the large steam boiler facilities that were initially developed from World War II into the 1970s by the major utilities. These facilities remain an important part of the overall system, providing both needed capacity for meeting peak demand and intermediate capacity to help meet annual energy requirements during low hydro years.

> **Finding:** Intermediate load-following ('swing') capacity plays an important role in California's electric system, providing the capacity needed for the system to respond to swings in availability of hydropower and imports. Natural gas-fired power plants provide the major portion of the state's swing capacity.

The combination of merit order dispatch, hydro resource variability, and changes in demand with weather patterns and economic conditions greatly complicate any assessment of the potential for new generating resources to displace existing generation. The new combined-cycle power plants have heat rates substantially below those of the existing fleet of gas-fired steam boiler facilities, which means that they will, within the constraints discussed above, be dispatched more often than the older plants. Theoretical assessments of the potential for such plants to displace existing generation can be conducted using computer simulation model runs by holding all input assumptions constant between two separate simulations except for the addition of a new power plant in one simulation. The difference in dispatch between the two simulations can be thought of as the theoretical displacement effect of the new power plant.

This type of assessment for the Western system typically shows that the new power plant is dispatched up to the limits of its assumed availability because of its relatively low cost of production. An equal amount of generation is reduced from existing power plants, but no individual power

Facility	Owner	Unit(s)	MW	Comments
El Segundo	NRG	1 & 2	339	Shut down 12/31/02 due to air permit requirements; Application for Certification for a combined cycle power plant to replace these units currently under review at the Energy Commission.
Etiwanda	Reliant	1 & 2	264	Units 1 & 2 currently unavailable due to need to install SCR; decision whether to retrofit and restart units is pending
Huntington Beach	AES	5	128	Unit 5 shut down as part of repowering of Units 3 & 4
Mountainview	Sold by AES to Intergen	1 & 2	126	Shut down 12/31/02; 1056 MW combined cycle replacement project approved by Energy Commission in March, 2001, but construction was delayed for financing reasons; Intergen expected to restart construction in summer 2003.
Broadway	City of Pasadena	1 & 2	93	

Units anticipated to shutdown or retire after January 1, 2003

Facility	Owner	Unit(s)	MW	Date	Comments
Morro Bay	Duke	1- 4		Uncertain	Application for Certification for a combined cycle power plant to replace these units currently under review at the Energy Commission.
Alamitos	AES	7	134	12/31/03	Peaker unit expected to be retired
Pittsburg	Mirant	1- 4	625	12/31/03	Units 1 & 2 have been shut down; units 3 & 4 are being shut down in 2003
Etiwanda	Reliant	5	120	2004	Peaker unit shut down
Hunters Point	PG&E	1& 4	219	Uncertain	Shutdown planned once reliability concerns in San Francisco are addressed; units 2 & 3 only operate as synchronous condensers

Table II-1
Recent and Anticipated Shutdowns and Permanent Retirements

plant is observed to drastically reduce its generation. As many as one hundred different power plants reduce generation to some generally small degree during certain hours. These results illustrate the type of response the system would exhibit, but cannot be considered predictive of the specific response that would occur. When even very small changes are made to the input assumptions about the heat rates of either the new or the existing power plants, a similar pattern of displacement is observed, but different power plants in different locations may be displaced instead, and at different times. Variation in demand and availability further complicate this assessment. For this reason, it is not possible to assess any specific displacement effect on existing generation from the addition of new power plants.

While specific displacement cannot be assessed in the overall dispatch of power plants, the owners of existing generation have made important decisions over the last decade that have resulted in the shutdown or permanent retirement of some old facilities. To a large degree, these economic decisions have been driven by air quality regulations that required reduced emissions if the steam boilers were to remain in operation. Most of those operating today have added selective catalytic reduction (SCR) systems to meet these requirements. Some project owners choose to replace the existing units with more efficient combined cycle units. For a few facilities, the owners have agreed to limit the hours of operation or shutdown the plants without specific plans to replace the units. **Table II-1** summarizes the current status of units that have been or are scheduled to shut down or retire.

> **Finding:** Displacement of existing electric generation to date has primarily occurred through decisions to retire old facilities or to replace them with new natural gas combined-cycle units. Such decisions have been driven in large part by the costs associated with upgrades that would be needed for some existing facilities to comply with current air emission regulations.

The Energy Crisis of 2000/2001

The summer of 2000 was a test of the operation of the restructured electricity market in California. Although the state avoided serious reliability problems that summer, the 32 days of Independent System Operator-declared emergencies and significantly higher electricity prices, particularly in San Diego, demonstrated the tight balance between supply and demand and the vulnerability of ratepayers and system reliability.

Although electric demand declined in the fall and winter months, the situation became worse during these months rather than better. Power plant availability rates were significantly lower than in previous years starting in June 2000 and continuing throughout 2001. Rotating outages were required to maintain the stability of the electric system in January, February and March 2001. Prices for both electricity and natural gas were significantly higher throughout this period, which impacted the financial viability of the state's investor-owned utilities (CEC 2001, CEC 2002).

The immediate symptoms of the crisis eased with the onset of summer in 2001. While the state experienced average temperatures that summer, the success in averting blackouts was largely due to the efforts to reduce demand and to increase supply from new power plants. The efforts of individual Californians to conserve electricity were particularly dramatic. In addition, wholesale prices began to return to pre-crisis levels starting in June, as federal price controls were imposed and the California Department of Water Resources entered into long-term contracts that reduced reliance on the spot market for electricity. The summer of 2001 passed in California with no rotating outages and a trend toward lower electricity and natural gas prices.

The crisis is important to the assessment of the environmental performance of the California electric generating system because the crisis could have had serious environmental and socioeconomic consequences. While the financial fallout from the crisis has been large, little evidence can be found for a significant environmental effect from the crisis. Because this report is focused on the performance of the electric generating system and not on the performance of the electric market, the financial fallout from the crisis is not addressed here. The following discussion summarizes the key socioeconomic and environmental effects of the operation of the physical generation system through the crisis.

Three major factors must be considered in evaluating the crisis. First, because of the tight supply/demand balance through most of this period, existing generators, at times including emergency backup generators, were called upon to operate more than anticipated. To a limited extent, this included allowing some units to operate beyond existing permit limits under the Governor's emergency orders. Second, new generating units were brought online quickly, both by expediting construction of projects that had already been permitted and by expediting permitting of new power plants. Finally, efforts to reduce peak demand in the state were very successful, so that electricity demand in the state was greatly reduced, softening the impacts that would otherwise have occurred. Each of these factors is discussed below.

Operational Changes

The energy crisis had the potential to cause an increase in air pollution emissions from electricity generation produced by the combustion of natural gas and oil. It was feared that extensive use of older units with limited air emission controls, and the frequent use of highly polluting diesel backup generators, would increase air emissions well above the levels experienced in recent years, which had seen a steady decrease in the air emissions associated with electricity generation. In fact, in-state natural gas-fired generation increased by 25 percent and 34 percent in 2000 and 2001 compared to 1999. Oil-fired generation, a very small portion of the state's generation picture, also increased from 0.02 percent of the in-state generation in 1999 to almost 0.2 percent in 2000 and just over 0.5 percent in 2001.

Under air quality rules dating from the early 1990s, emission reductions were required of existing steam boiler power plants. Many of the resulting pollution control retrofits had been completed before the crisis, which helped reduce the electricity generation sector's contribution to air pollution. Some variances and delays were granted during the crisis for power plants that had not yet complied with the rules. Most retrofits were completed by the end of 2001, though full implementation of these rules is not now scheduled until 2005.

Despite the increased use of natural gas and oil power plants and the delays in some pollution control retrofits, overall emission of oxides of nitrogen (NOx) from electricity generation in California decreased in 2001. Several reasons account for the emissions decrease from 2000 to 2001.

First, though some pollution control retrofits were delayed, retrofits were completed on 17 power plants by the end of 2001. Pollution control equipment installed typically reduces NOx emissions by 80 to 90 percent. Second, energy conservation efforts greatly reduced the overall demand and meant that poorly controlled units did not need to operate frequently. Third, the startup of 11 new power plants with state-of-the-art emission controls by the end of the summer of 2001 further reduced reliance on older facilities that have operated infrequently due to their high heat rates (low efficiencies). Finally, the avoidance of blackouts and power curtailments during the summer of 2001 meant there was little need to use diesel back-up generators and the very high emissions from these units were avoided.

While statewide NOx emissions decreased in 2001, the crisis triggered competition for emission credits in the South Coast Air Basin that resulted in an emergency rulemaking. In 2001 and 2002, one of the air pollution credit trading markets was upset by high demand from the generation sector. The South Coast Air Quality Management District acted to stabilize the program through a number of actions, including separating electric generators from the rest of the market until January 1, 2004, and placing power plants under enforceable plans that require installation of pollution control equipment on boilers by January 1, 2003 and on turbines by January 1, 2004.

Expedited Permitting and Construction

Power plant permitting was expedited during the crisis. Legislation initially adopted in 2000 required the Energy Commission to develop a four-month permit process for projects that could be online by August 2001, with the law amended during 2001 to apply to projects that could be online by December 2002. The Governor also issued a number of emergency executive orders in February 2001 that were intended to increase electricity supplies in 2001 and 2002. Under these orders, simple-cycle power plants that could be online by the end of September 2001 were exempted from the requirements of the California Environmental Quality Act. The Energy Commission, working in close coordination with other state and federal agencies, established an emergency permit process for such power plants within its jurisdiction, including projects less than 50 MW that had contracts with the California Independent System Operator or the Department of Water Resources. Under this process, the Energy Commission and local air districts reviewed the potential environmental impacts and determined whether mitigation was necessary. Air quality permits were prepared for these projects by the local air districts and included in the Commission's decisions.

On the supply side, more than 2,400 megawatts of new generation were brought on-line during the summer of 2001, and an additional 3,400 MW were added by the end of the summer of 2002. These included more than 3,300 MW from projects that had been permitted by the Energy Commission before the start of the crisis and approximately 900 MW permitted by the Energy Commission during the emergency, with the rest being restarts and rerates of existing projects and new renewable projects or smaller projects that were not within the Energy Commission's jurisdiction.

Because delivery and installation of SCR catalysts was a potential bottleneck for bringing some of these projects online, variances were granted to some project, to allow startup before SCR was installed and operational. This allowed those projects to operate for up to one year at 25 parts per million (ppm) for NOx, rather than the 5 ppm that was required once the SCR was installed. In addition, the projects were allowed to offset some emissions for up to three years through the state's Carl Moyer program, which was based on control of mobile sources. Both these actions had the potential to result in local impacts during the initial years of operation greater than would have otherwise been allowed.

All the emergency peakers installed to reduce summer peak loads in 2000 and 2001 were sited on areas one to five acres in size, were within barren lots (with no vegetative cover), irrigated farmland, or desert scrub that was designated for energy generation (Appendix V, Data Table 3), and most were located in the vicinity of existing substations. Simple cycle peakers have relatively little water requirements, so there was a minimal impact on water resources. No wetland losses resulted from construction of the peakers, and biological resource impacts were few and fully mitigated. Thus, development of California's electric generation system during the energy crisis had minimal environmental impact.

Demand Reduction

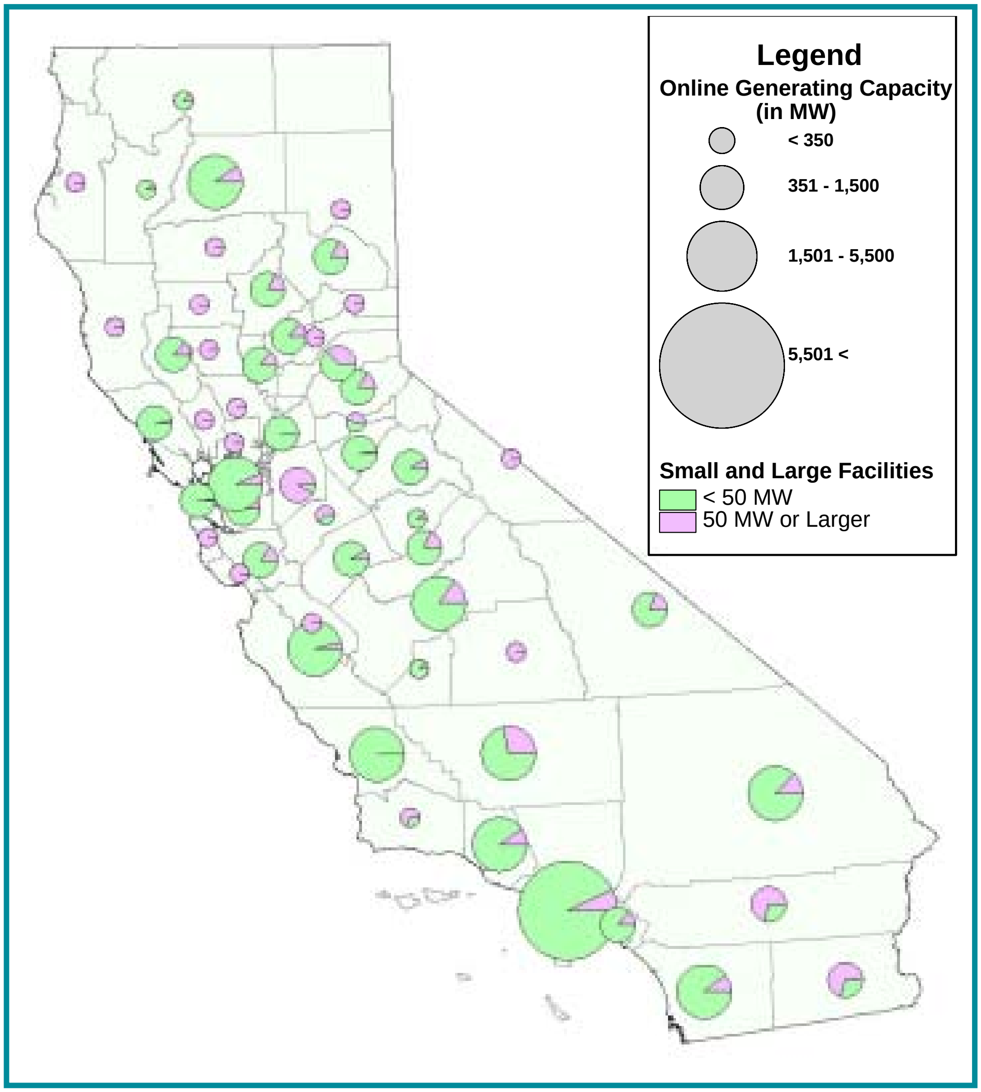
While the state experienced average temperatures during the summer of 2001, blackouts were avoided largely due to the efforts to reduce demand and increase supply. The efforts of individual Californians to conserve electricity were particularly dramatic. Combined with energy conservation programs, peak demand that summer was reduced by 14 percent, 11 percent and 9 percent in June, July, and August, respectively, after being adjusted for weather and economic growth. On the energy conservation side, peak reduction reached a record high of 5,570 megawatts on June 21, 2001. At that time, over 300 megawatts were attributed to recently enacted energy efficiency programs. In addition, voluntary conservation efforts by businesses and consumers – such as setting the thermostat at 78 degrees or to "off" and installing energy savings devices, such as compact fluorescent lights – yielded an additional 5,248 megawatts in savings. Another 3,200 megawatts would have been available from voluntary interruptible customers had the situation become critical.

These efforts were significant in helping the state avoid rotating outages and in reducing the overall demand for energy. Because overall electric energy consumption in the state in 2001 was 5.5 percent below the level in 2000 and 3 percent below the level in 1999, in-state generators did not need to operate as much as they would have without this dramatic conservation effort. This reduction was a key factor in the limited environmental impact of the crisis.

Geographic Distribution of Power Plants in California by County and Facility Type

Los Angeles, San Diego, Contra Costa, and San Luis Obispo have the largest amount of installed generation (see **Figure II-10**). Although these counties are along the Coast or on the San Francisco Bay Delta, San Bernardino and Kern Counties are also major electricity producers despite the lack of large bodies of surface water for power plant cooling. All counties except Alpine, Del Norte, Marin, Modoc, and San Benito have some electric generating facilities with capacity of at least 100 kW. **Figure II-10** also shows a breakout between large (50 MW or larger) and small electric generating facilities.

Figure II-10
Electric Generation Capacity by County



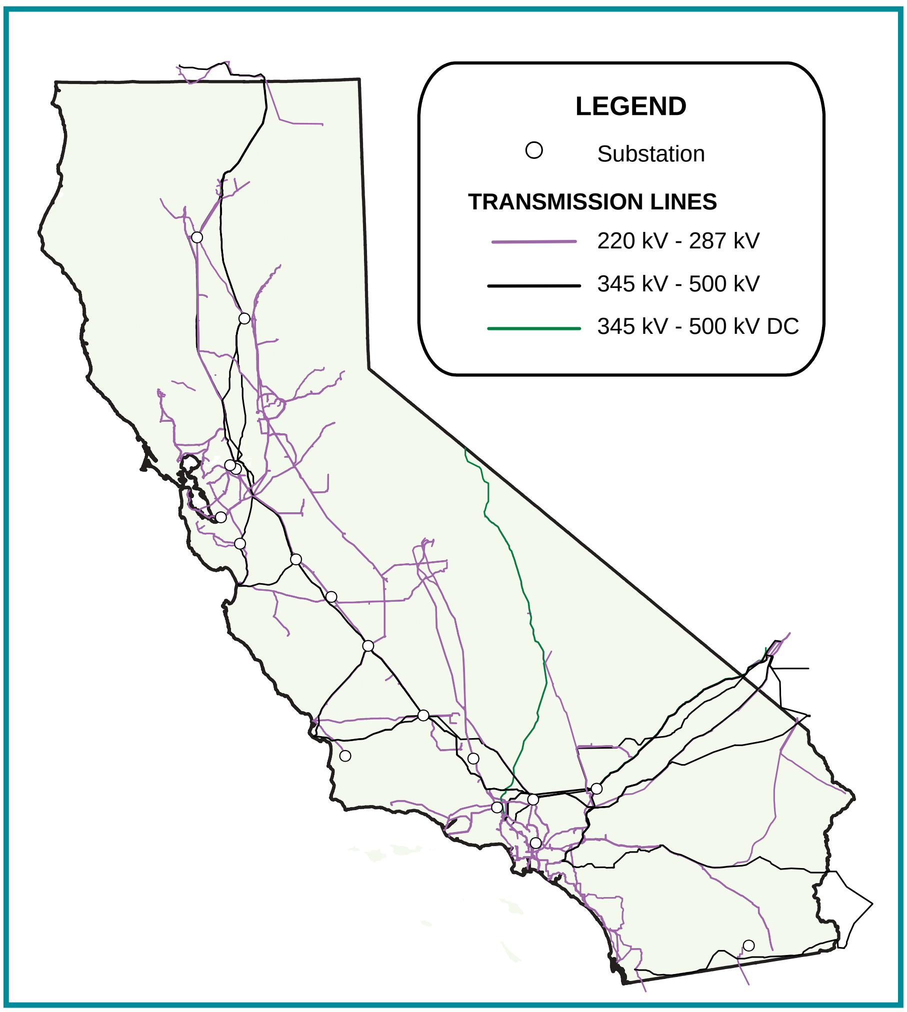
Generation facilities in some locations play a special role in maintaining the electric system. Some units operate to provide voltage support and other grid reliability services. Specifically, the Cal ISO annually designates electric generating units as "Reliability Must Run" (RMR) because of their locations within one of seven local reliability areas. Most RMR units are located in Northern California (i.e., the PG&E service area), but many are clustered in Los Angeles and San Diego as well. In fact, most electric generating units in San Diego are designated as RMR facilities. Most RMR facilities are hydroelectric or oil/gas power plants, but RMR facilities can also be waste-to-energy and geothermal power plants.

Other Electric System Infrastructure

Electricity Transmission Infrastructure

As discussed above, California is part of an interconnected electric system throughout the west that allows imports and exports across the region based on regional differences in demand and supply patterns. The bulk electricity transmission grid provides the mechanism for these transfers. Lack

Figure II-11
Major Transmission Lines in California

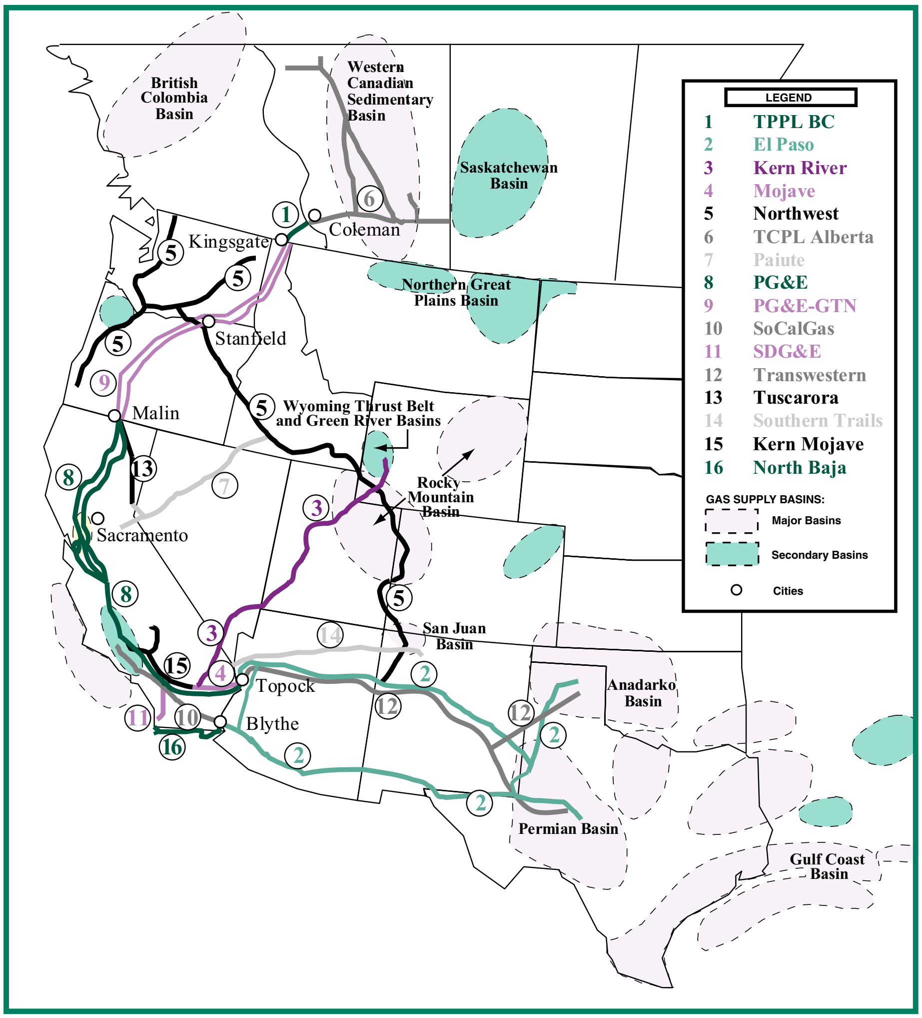


of sufficient capacity on the transmission grid can make it difficult for grid operators to fully capitalize on the system-wide economic benefits of recent resource additions in and around California. **Figure II-11** shows California's major transmission system infrastructure. California's investor-owned utilities plan, develop, and complete electricity transmission projects to address local reliability needs within their respective service territories.

Natural Gas Infrastructure

The major new generation capacity additions in California and the rest of the West are predominantly fired by natural gas. California depends heavily on out of state supplies of natural gas. Reliable performance of the state's electric system depends on the ability of the major pipelines to deliver gas to California and to distribute gas to customers and storage sites within the state. **Figure II-12** shows the major natural gas pipelines within California.

Figure II-12:
Western North American Natural Gas Pipelines



June 2003

Environmental Performance Report
Chapter 3
Environmental Performance

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Chapter 3: Environmental Performance

This chapter examines the environmental performance of California's electric generation system. A detailed assessment is presented of the environmental effects of the system on air, biological, and water resources. These assessments have established as a baseline the conditions in 1996, the year that the deregulation of the system was enacted into law. Each section analyzes the trends in environmental performance from 1996 through 2002. In addition, the chapter presents an initial discussion of the effects of the system on cultural resources.

"Environmental performance" for energy systems consists of several factors, including:

- thermal efficiency
- environmental discharges
- environmental quality effects
- environmental efficiency

Thermal efficiency is the measure of the effectiveness of converting the heat content of various fuel sources to electrical energy. Environmental efficiency is the measure of units of environmental discharge and impact per unit of energy produced. Environmental emissions and discharges are measured in tons of pollutants emitted to air, acres of habitat displaced, or gallons of water used. Discharges create varying levels of impact to environmental quality. A given power generation facility can cause varying levels of impact to an air basin, watershed or ecosystem.

Changes in thermal efficiency, environmental efficiency and rates of environmental discharge result from changes in generation and pollution control technology, economics, changes in environmental regulation. Changes in scientific understandings of natural systems can also affect how the effects of electric generation on the environment are understood and measured.

The ***2003 Environmental Performance Report*** focuses on changes in thermal efficiency and emissions since 1996. The environmental quality effects from power generation and transmission need to be assessed in the context of impacts from other sectors, such as vehicle use and land development. Understanding and documenting the contributions of California's electric generation and transmission system to environmental quality trends for air, water and biological resources in specific geographic locations is a long-term goal for the Energy Commission. The data, analytic capacity and staff resources required for such an assessment are probably beyond the means of any singly agency.

Environmental Performance Report
Chapter 3
Environmental Performance:
Air Resources

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Air Resources

Summary of Findings

- Statewide, fuel-fired electric generation contributes a relatively small portion of the state's NOx and PM10 inventories. Between 1996 and 2002, the generation emissions and emission percentages are relatively flat.
- In-state fired electric generation reliance on natural gas, the cleanest of the available fuels, has benefited the state's air quality, but may limit easy opportunities for additional NOx, PM10, and CO2 emission reductions via switching to natural gas.
- Further improvements in air emissions performance of the generation sector must come from technological advances in emissions control or by decreasing reliance on fired generation through reduced demand or increased use of non-fired electricity sources. Agency coordination and research will be critical components to timely and cost-effective technology advances.
- While over 85 percent of California fuel-fired generation control or limit air emissions, deployment of additional retrofit emission control equipment will depend on ongoing cost reductions for equipment, dispatch of existing units, the attainment status and air quality management plan of the district, and retrofit proceeding at CARB.
- Implementation of the retrofit rules for utility boilers over the last decade has resulted in 80 to 90 percent reductions in NOx emission rates per MWh from these facilities.
- The new combustion turbine retrofit guidance document proceeding at CARB could realize emission rate improvements and emission reductions for various California combustion turbine generation units. The development or these rules, and implementation by districts, may affect the availability and cost effectiveness of these combustion turbines.
- At the time, restructuring was not expected to alter the positive air quality trends for NOx and PM10. Divestiture forced some air districts to change their NOx retrofit rules for utility boilers to accommodate changes in ownership.
- The load-following facilities, or approximately 60 percent of the fuel-fired generation, achieved nearly a 50 percent reduction in average NOx emission rate. The improving NOx emission rate partially ameliorated an increase in NOx emissions during 2000 and 2001 energy crisis and reduced 2002 NOx emissions from 1996 levels.
- PM10 emissions rates appear to have improved between 1996 and 2002, however, better data would confirm the trends.
- California needs continued air emission reductions from the generation sector. Our air quality infrastructure can, and should, provide practical and innovative rules to address both existing and new generation sources, resulting in appropriate emission reduction contributions from the generation sector.
- In general, imported power causes minimal air quality effects within California, except potentially near the Mexico border. Out-of-state generation appears to exhibit an improving NOx emission factor, possibly due to the increased use of natural gas. Despite NOx and CO2 emission rates being higher for out-of-state generation, significant differences in air quality settings make it difficult to predict how the plants might contribute to out-of-state air quality.

Introduction

Electricity for residential, commercial, and industrial consumers is crucial to the well being of the people of California, as is good air quality. Control of air pollutant emissions from power generation facilities is fundamental to maintaining good air quality. Because electricity generators within California use various means to produce electricity, a variety of approaches are used to control these emissions.

The ***2001 Environmental Performance Report*** described the trends in air emissions from California generation facilities from 1975 to 2000. This 2003 report analyzes recent trends in emissions, generation and emission control technologies, and air regulations for California electricity generation using fuel combustion. The focus on 1996 to 2002 is intended to capture any perturbation due to electricity deregulation, power plant divestiture, and the 2000/2001 energy crisis.

California Generation System Emissions 1996 to 2002

In order to evaluate the environmental footprint of the California generation units, staff evaluated California Air Resources Board (CARB) data on total emissions and emissions from different sectors of the state economy. Staff attempted to augment this data in order to provide facility-specific information on the major fuel-fired generating facilities in state. Staff discussed the CARB data with CARB staff and reviewed the federal Energy Information Administration and US Environmental Protection Agency (US EPA) databases. At best, the data are inconsistent across the various databases. At worst, the data are incomplete or out of date. Staff will continue to work with CARB and other agencies to improve the consistency and reliability of detailed data on power plant emissions.

Pollutant	Source of Emissions	1995 [1]	1996 [2]	1997 (est.)	1998 (est.)	1999 (est.)	2000 [1]	2001 [3]	2002 [1]
NO_x	From All Sources	4,152	3,300	3,381	3,463	3,545	3,629	3,441	3,038
	From CA Power Generation	115	91	93	95	97	99	84	92
	% Power Generation	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%	2.4%	3.0%
PM10	From All Sources	2,286	2,300	2325.5	2351	2376.5	2,402	2,418	2,126
	From CA Power Generation	8	8	8.35	8.5	8.8	9	10	10
	% Power Generation	0.35 %	0.35%	0.35%	0.36%	0.37%	0.37%	0.41%	0.47%

1. Based on 2003 Almanac, adjusted by CARB
2. CARB 1996 Inventory
3. CARB 2002 Almanac, not adjusted

Table III-1: Comparison of Statewide Emissions with Emissions from Power Generation (tons/day)

Table III-1 presents the NOx and PM10 data from CARB Annual Air Quality Almanacs (CARB 2001a, CARB 2003). The data are a combination of reported values and estimated values using growth and control factors for some sectors. The growth factors used by CARB could not anticipate the 2000 and 2001 energy crisis and the resulting surge in in-state fuel generation. The 2003 Almanac provides an initial correction for the inventory numbers for the years 2002, 2000 and 1995. CARB is evaluating some correction to some of the generation sector numbers for 2001. The fact that the inventory numbers for 2000 and 2002 have been corrected after review by CARB staff but the 2001 numbers have not yet been corrected results in an apparent anomalous drop in generation sector emissions in 2001.

However, the published numbers provide a starting point for discussion of emission trends, and place the emissions from the electric generating sector in the context of overall state-wide emissions.

Pollutant	Source of Emissions	1999
CO2	From All Sources	381.1
	From CA Power Generation	61.0
	% Power Generation	16%

Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999
November 2002, Publication #600-02-001F, California Energy Commission.

Table III-2: Comparison of Statewide CO2 Emissions (equivalent) with CO2 from Power Generation (million tons/year)

The following analysis focuses primarily on NOx emissions, since this is the primary criteria air pollutant of concern from the electric generating sector in California. PM10 and CO2 emission estimates are also presented. PM10 is the other major criteria pollutant of concern in terms of ambient air quality in the state. **Table III-2** provides a calculated 1999 CO2 (equivalent) inventory for California to provide context for CO2 trends from the generation sector. Greenhouse gas emissions from electricity generation are described in more detail in the ***2003 Electricity and Natural Gas Report***.

- **Finding:** Statewide, fuel-fired electric generation contributes a relatively small portion of the state's NOx and PM10 inventories. Little change in the generation emissions and emission percentages occurred between 1996 and 2002.

Air Pollutant Emissions and Air Quality

Over 90 percent of Californians breathe unhealthy levels of one or more air pollutants during some part of the year (CARB 2003). California's relatively poor air quality is the result of complex interactions of climate, topography, and air pollutant emissions. In addition to being unhealthy for humans, air pollution can threaten the health of trees, lakes, crops, and animals, and it can damage historic buildings or affect the global climate and the ozone layer. Air pollution emissions can also cause haze, which reduces visibility.

Air pollution comes from many different sources, including power plants, factories, motor vehicles, dry cleaners, , and even windblown dust and wildfires. Electric generation facilities emit criteria or "traditional" pollutants, toxic air contaminants, and greenhouse gases.

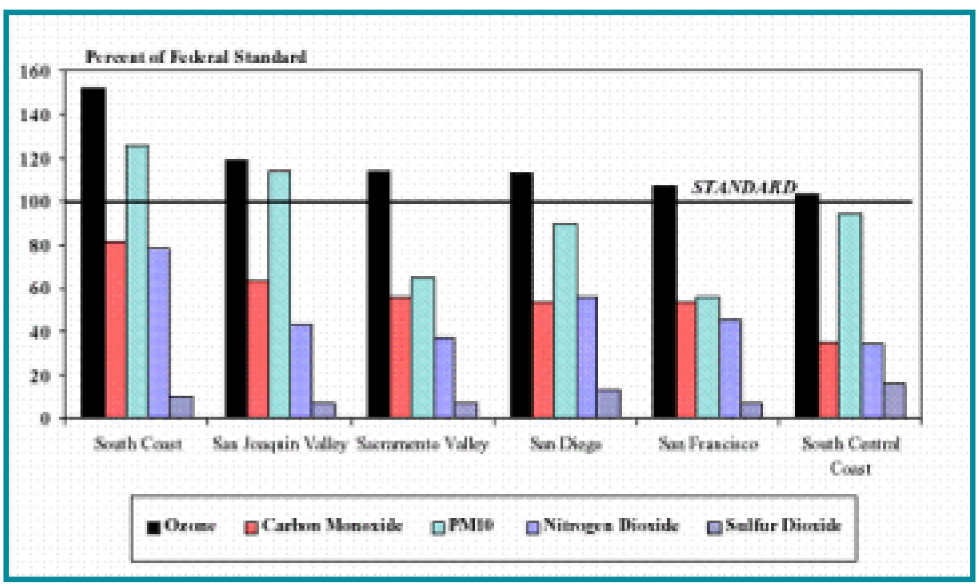
Criteria Air Pollutants

Criteria pollutants are those outdoor air pollutants that have ambient air quality standards, which are concentration levels that are considered safe for the public. The characteristics of the criteria pollutants, ozone, carbon monoxide, oxides of nitrogen, sulfur dioxide, and particulate matter, are described in Appendix III-1.

The federal and state Clean Air Acts require both the US EPA and CARB to establish ambient air quality standards. The ambient standards protect not only the general public, but also senstive receptors that are considered to be at risk, such as the young, elderly or asthmatics. Areas are designated as attainment, non-attainment, or unclassified depending on a comparison of locally monitored data with the federal and state ambient standards. **Figure III-1** shows the maximum concentrations, relative to the short-term federal standards, for each criteria pollutant in the major air basins in the state in 2001. **Figure III-1** does not reflect the state short-term ambient air quality standards, which are more stringent for ozone and PM10. All the regions shown are non-attainment for the state PM10 standard.

Because ozone and particulate matter are the two criteria pollutants of greatest concern in California, this discussion focuses on the primary ozone precursor, NOx, and also looks at PM10 emissions from the fuel-burning portion of the generation sector.

Figure III-1:
Maximum Air Quality Concentrations in the Major Air Basins in California for 2001 (as percent of short-term federal AAQS)



Source: South Coast Air Quality Management District, 2003 Draft Air Quality Management Plan.

Toxic Air Contaminants

Unlike criteria pollutants, toxic air contaminants (TACs) do not have associated ambient air quality standards. Some TACs may accumulate in the body from repeated exposures, and may cause a wide variety of disorders, such as cancer, chronic eye, lung, or skin irritation, and neurological or reproductive disorders. Over 200 substances qualify as TACs. As new TACs are identified, measures are adopted to reduce emissions of these contaminants and reduce the risk to the general public. Power plants typically emit TACs in much smaller quantities than criteria pollutants. The most common are ammonia, formaldehyde, and particulate matter from diesel combustion. In siting new facilities, potential health risks from exposure to TACs are addressed through a health risk assessment, which complements the criteria air pollutant analysis required under the federal and state Clean Air Acts.

Greenhouse Gases

A number of greenhouse gases are released during power generation. Of these, CO2 is emitted in the largest quantity, followed by nitrous oxide, methane and hydrofluorocarbons. Although the possible effects of global climate change are not analyzed in this report, climate change may affect the timing, location, and persistence of poor air quality. For example, ozone formation is a function of temperature. Increases in local ambient temperatures could result in increased ozone levels. Greenhouse gas emissions from electricity generation are described in the ***2003 Electricity and Natural Gas Report***.

Actions taken to reduce greenhouse gas emissions can also reduce air pollutant levels. For example, increasing generation efficiency serves to reduce both CO2 and air pollutant emissions per MWh generated. The capture of landfill gas and its use as a generation fuel reduces landfill emissions of methane, a greenhouse gas, while also reducing criteria pollutant emissions from landfill flares. Potential actions are discussed in technical companion volumes to this report.

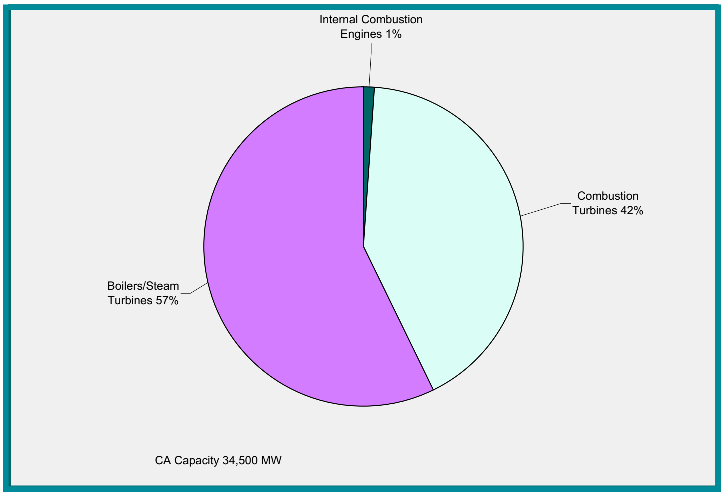
Factors Affecting Air Emissions

Electric Generation Technology

Emissions and emission trends from power generation depend on the generation technology, the energy source, and the air emission controls and regulations. This section focuses on the "fired" portion of the power system, because generation by solar, wind, nuclear, or hydroelectric processes generally avoid air emissions from fuel combustion. Geothermal generation, while not firing fuels, can emit quantities of hydrogen sulfide, ammonia and carbon dioxide. These emissions are not analyzed in this report.

Fired units can be found operating throughout the state, with capacities ranging from one kilowatt to thousands of megawatts. The units are primarily either fuel-fired boilers supplying steam to a turbine or fossil fuel-fired combustion turbines operating in simple-cycle mode (just the combustion turbine) or combined-cycle mode (using the waste heat to generate steam to run a steam turbine). Internal combustion or reciprocating engines are only one percent of the total installed capacity that is fuel-fired (see **Figure III-2**). The boiler/steam turbine power plants have efficiencies that range from about 30 percent to near 40 percent. Older simple-cycle combustion turbines are less than 30 percent efficient, while modern simple-cycle turbines are approaching 40 percent. Most of the new capacity that has been added to the system in recent years in California consists of combined-cycle power plants that can be greater than 55 percent efficient. As the fired generation fleet turns over, with these new facilities replacing boilers and less efficient combustion turbines, total emissions and emissions per MWh will improve.

Figure III-2:
Technoogy Types - In-state "Fired" Generation Capacity



California's fuel-fired units operate across the dispatch profile: baseload, intermediate or load following, and peaking. (These operating modes are described in the previous chapter.) Some units are more commonly operated in peaking or load-following duty cycles because of their quick responsiveness to load changes and startup demands, and others are operated in baseload due to cost or cogeneration obligations.

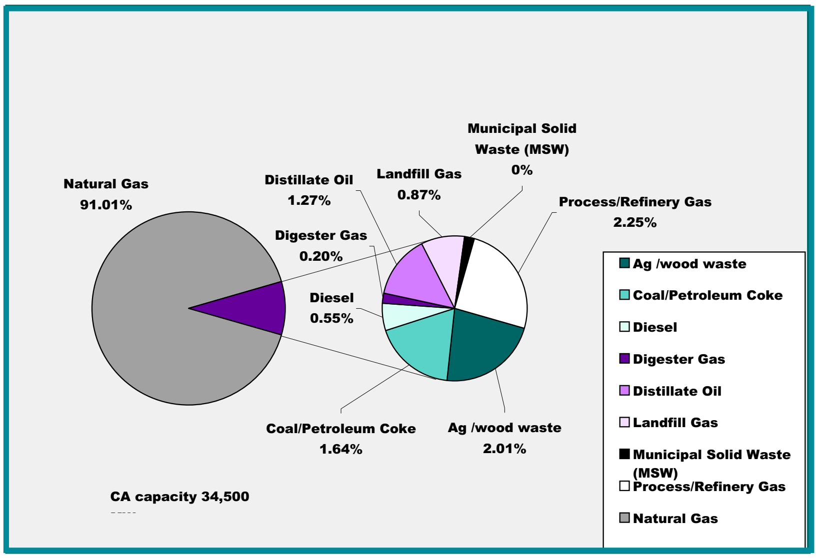
Fuel Type

Electric generating station fuel types include agricultural and wood waste, coal/petroleum coke, diesel, digester gas, distillate oil, landfill gas, municipal solid waste, process/refinery gas, and natural gas. The largest, and fastest growing, segment of the generating capacity in California is fueled by natural gas. Natural gas is the preferred fuel because of its cleaner combustion compared to other fuels. It has negligible sulfur, which limits sulfur compound emissions; negligible ash, which limits PM10 emissions; and NOx emission rates that are generally lower than from other fuels.

Staff examined the installed fuel-fired capacity of the system, shown in **Figure III-3,** to illustrate the current extent of the dependence on natural gas. Although a balanced range of electricity sources provides the in-state dependable capacity, the contribution of electricity from natural gas continues to grow.

The existing and expanding reliance on natural gas raises several issues. The broad use of natural gas provides fewer opportunities for fuel switching to reduce NOx, PM10, or CO2 emissions from existing generators. Increasing reliance on a single energy type, most of which is produced and delivered from locations outside of California, increases the potential for price spikes and supply and delivery interruptions. The price, availability, and reliability of electricity from the natural gas-fired portion of the power system are dependent on the supply/demand balance for natural gas in the western United States. Prices and reliability concerns may increase due to steady increases in

Figure III-3:
Fuel Use In-State Fired Generation Capacity



Note: Total in-state fired generation capacity is approximately 34,500 MW, or almost 60 percent of total in-state capacity. "Fired" generation includes those technologies that rely on fuel combustion.

demand, weather induced demand spikes, and fewer units capable of fuel switching between natural gas and oil. These issues will be discussed in more detail in the ***2003 Electricity and Natural Gas Report***, which is being prepared as part of the Integrated Energy Policy Report.

Control of CO2 from Generation

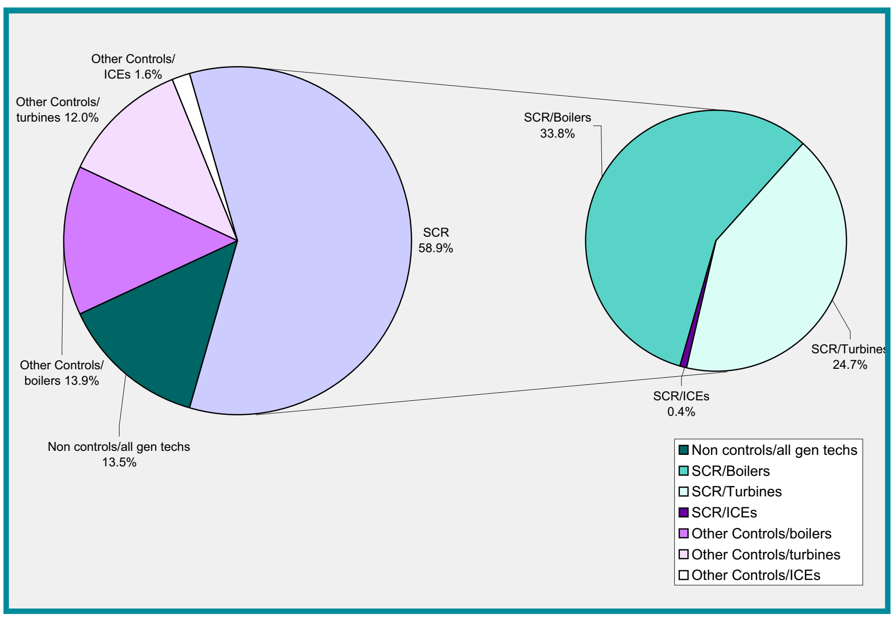
One of the simplest and cheapest CO2 control measures that many states and countries may implement is switching from coal and oil to natural gas-fired generation. Coal and oil produce about 1.8 and 1.4 times, respectively, as much carbon per mmBtu as natural gas (ICF 1999). Because a significant amount of California generation already uses natural gas, whether for cost, ease of permitting, or air quality compliance, the state has fewer opportunities in the generation sector to switch to natural gas for additional CO2 reductions

- **Finding:** In-state fired electric generation reliance on natural gas, the cleanest of the available fuels, has benefited the state's air quality, but may limit easy opportunities for additional NOx, PM10, and CO2 emission reductions via switching to natural gas.
- **Finding:** Further improvements in air emissions performance of the generation sector must come from technological advances in emissions control or by decreasing reliance on fired generation through reduced demand or increased use of non-fired electricity sources. Agency coordination and research will be critical components to timely and cost-effective technological advances.

Emission Control Technologies

More than 85 percent of the internal combustion engines, combustion turbines, and boilers have some type of NOx control on the system. Nearly 21,000 MW, or almost 60 percent, of the fuel-fired generation uses selective catalytic reduction (SCR) for NOx emission control. Most solid-fueled systems use non-catalytic NOx control technologies. **Figure III-4** shows the variety of NOx control technologies used by the fired portion of the system.

**Figure III-4:
NOx Control Technologies for In-State Fired Generation Capacity**



Because of the extensive use of natural gas, few units within the system use additional PM10 or SO2 control technologies. PM10 and SO2 emissions occur in very small quantities when firing natural gas compared to firing liquid or solid fuels. In fact, natural gas is considered Best Available Control Technology for PM10 and SO2 control. Most solid fuels (e.g., coal, petroleum coke, biomass) are combusted in boilers with particulate control (baghouses or electrostatic precipitators) and some SO2 controls. There are no explicit CO_2 controls in use in the system, however, the broad use of natural gas and the steady increases in average generation efficiency (see **Figure II-6**, above) have decreased the amount of CO2 emitted per MWh.

While over 85 percent of the fired generation system already controls or limits air emissions, particularly NOx, opportunities still exist to install controls on existing units to reduce emission factors and emissions. Any decision to retrofit an existing source must balance the cost of the retrofit with the tons of pollutant reduced. For low capacity and peaking units, even those with relatively high emissions factors, the limited tons of pollutants emitted during a year may not lead to a finding of cost effectiveness with the most stringent retrofit technology.

In addition, the location of the source can dictate whether or not a project needs to retrofit to reduce emissions. A relatively uncontrolled generator may be located in an air district that does not need or require emission reductions from the generation sector. Ror this reason, not all generation units in California that do not currently use NOx controls will necessarily be required to install such controls. Decisions to install new emission control equipment will depend on ongoing cost reductions for equipment, dispatch patterns of existing units, the attainment status and air quality management plan of the district, and retrofit proceeding at CARB and the districts (see discussion below).

- **Finding:** Over 85 percent of California fuel-fired generation control or limit air emissions. Deployment of additional retrofit emission control equipment will depend on ongoing cost reductions for equipment, dispatch of existing units, and the attainment status and air quality management plan of the district.

Emission Regulations

Air quality regulations limit emissions from new sources through stringent performance standards and garner reductions from existing sources through retrofit requirements. Regulations can impose fuel requirements, emission controls, offsetting emission reductions, or operation curtailments to limit emission factors and total emissions from a source.

New Source Review

New Source Review rules allow new sources to be constructed and operate while either maintaining or improving air quality through offset programs that result in no net increase or in reductions of emissions inventories. This program provides a program for offsetting emission reductions ensures that new equipment minimizes its emissions. All large new sources must meet the current state-of-the-art performance standards by installing the Best Available Control Technology. The definition of Best Available Control Technology, which is based on the emission rates achievable by current technology, gradually becomes more stringent over time, as new, lower-emitting equipment evolves. This continuing decrease in emission rates allowed for new sources helps to continually improve the efficiency and environmental performance of additions to the power system.

Retrofit Rules

The methods used by each air district to manage existing sources vary depending on the sources within the district and the district's attainment status. Because each power plant must comply with a district permit, the district can establish a maximum emission rate that becomes more stringent over time. California air districts promulgated a set of Best Available Retrofit Control Technology rules in the early 1990s designed to achieve significant reductions in NOx and CO emission rates and total emissions from utility boilers between the late 1990s and 2005. Most of the retrofit rules were designed to achieve 80 to 90 percent reductions in the emission rate and their implementation has helped produce a significant reduction in NOx emission rates for the affected facilities, as is discussed below. The total emission reduction depends on the extent to which each unit operates from year to year. Many of the units subject to these rules are swing units with annual capacity factors that can vary significantly based on availability of in-state hydropower and imports.

CARB recently initiated a new round of retrofit proceedings targeting combustion turbines. CARB anticipates that a guidance document will be available for consideration by the Board in the fall of 2003. Individual districts will be responsible for adopting rules targeting specific turbines. Potential issues for this proceeding include the cost effectiveness threshold, calculation of the baseline or historical capacity factor, and the estimation of projected capacity factor. Options for control or compliance for existing combustion turbines could include shutdown, curtailment, fuel switching, and emission control equipment retrofit. These in turn could raise issues with respect to the cost, availability and reliability of electricity to the system.

Regional Clean Air Incentives Market

In 1994 the South Coast Air Quality Management District created a market-based retrofit rule for NOx and SO2 called the Regional Clean Air Incentives Market (RECLAIM) program (Regulation XX). Power plants were exempted from the SO2 portion of RECLAIM. This rule established a facility emission cap that was annually reduced. Unlike more prescriptive BARCT rules, RECLAIM sources could choose to comply with their annual cap by retrofit, process curtailment, shutdown, or purchasing excess emissions from other RECLAIM participants. Initially, most NOx RECLAIM participants, including power plants, purchased emission reductions rather than installing emission control retrofits.

Coincident with the 2000/2001 energy crisis, fierce competition for NOx emission credits in the South Coast Air Basin resulted in increased NOx emission credit prices and a stagnant trading market. Since many participants had not opted to retrofit earlier, the market could not quickly respond to the surge in in-state fired generation to make up for hydro and imported electricity shortfalls. Some generators chose to temporarily shutdown rather than buy the credits at the extraordinary market prices. Other chose to pay fees to the air district.

The District initiated an emergency rulemaking to stabilize the program, which included separating electric generators from the rest of the market until January 1, 2004, and placing power plants under prescriptive and enforceable plans that require installation of pollution control equipment on boilers by January 1, 2003 and on turbines by January 1, 2004. Some plant owners have negotiated agreements with the District modifying the compliance date and compliance plan (*e.g.*, power plant replacement instead of emission control retrofit). Prices for NOx RECLAIM trading credits have since returned to pre-2000 levels.

- **Finding:** Implementation of the retrofit rules for utility boilers over the last decade has resulted in 80 to 90 percent reductions in NOx emission rates per MWh from these facilities.

- **Finding:** The new combustion turbine retrofit guidance document proceeding at CARB could realize emission rate improvements and emission reductions for various California combustion turbine generation units. The development of these rules, and implementation by districts, may affect the availability and cost effectiveness of these combustion turbines.

Emissions Trends since Deregulation and Divestiture

Deregulation and divestiture have changed the power system within California, but have not substantially influenced trends in air emissions from the system. Market restructuring has encouraged the continued use of existing facilities, particularly those with little or no capital investment to be recovered. Although these are generally older and less environmentally efficient energy facilities, deregulation did not relieve any energy producer from the established air quality regulations, including retrofit rules and new source review rules.

Early in the deregulation process, the investor-owned utilities (Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric) divested almost all of their fossil-fueled generation capacity. (Pacific Gas and Electric retained ownership of the fossil-fueled Hunters Point and Humboldt power plants.) As part of the review of the divestiture, the California Public Utilities Commission prepared environmental documents that concluded that any significant air quality impacts could be mitigated or would be temporary. The California Public Utilities Commission recommended that local air districts revise retrofit rules, where appropriate, to accommodate the ownership changes resulting from the sale of the facilities by the utilities, which the air districts did.

In 1999, the Energy Commission recommended coordination between local, state, and federal air pollution control agencies to ensure the timely permitting of new energy facilities and the consistent implementation of existing retrofit rules (CEC 1999). During the 2000/2001 energy crisis, the Energy Commission worked with CARB, the districts and the US EPA to design and implement an expedited power plant siting process. The process required the districts to issue air permits, and include identification of impacts and appropriate mitigation.

- **Finding:** At the time, restructuring was not expected to alter the positive air quality trends for NOx and PM10. Divestiture forced some air districts to change their NOx retrofit rules for utility boilers to accommodate changes in ownership.

Air District Retrofit Rules (Utility Boilers)

Bay Area AQMD: Divested utility boilers fell outside of the requirements of the rule. The District revised the rule in 1999 to address the divestiture of Hunters Point 2-4, Potrero Unit 3, Pittsburg Units 1-7, and Contra Costa Units 1-4. Hunters Point is to be closed as soon as possible, per an agreement between PG&E and the City and County of San Francisco. The Rule will be fully implemented by 2005.

Monterey Bay Unified APCD: Divested utility boilers would have fallen outside of the requirements of BARCT Rule 431. The District revised the rule in December 1997, and the requirements for Moss Landing Units 6 & 7 have been fully implemented.

San Luis Obispo County APCD: Divested utility boilers would have fallen outside of the requirements of BARCT Rule 429. The District revised the rule in December 1997 to apply to Morro Bay Units 1-4 and is enforced the revised rule.

Ventura County APCD: Divested utility boilers would have fallen outside of the requirements of BARCT Rule 59. The District revised the rule in July 1997 such that the rule applies to Ormond Beach Units 1 & 2 and Mandalay Units 1 & 2, and has fully implemented the rule.

South Coast AQMD: Under Regulation XX: RECLAIM, facilities, including some power plants, have an annual emissions allocation. Facility compliance with the allocation can be through emission controls, emission credit trading, or process modification or curtailment. Power plants not covered by RECLAIM are subject to Rule 1135, which has daily and annual emission caps.

Mojave Desert AQMD: Retrofit Rule 1158 has an annual emission cap for Coolwater Units 1-4 and includes language for successor owners.

San Diego County APCD: Retrofit Rule 69 has an annual emission cap for utility owned boilers. The rule requires adjustment of the cap if units are sold and specifies the control levels for the sold units. The rule applies to South Bay Units1-4 and Encina Units 1-5. Encina applied for and obtained a variance to allow more time to install selective catalytic reduction (SCR) or emission controls.

NOx Emissions 1996 to 2002

Most of the generation capacity added in California in recent years has used simple-cycle or combined-cycle combustion turbine technology. These units are highly efficient, can be highly controlled for NOx, primarily through the use of SCR, and exclusively use natural gas to control PM10 and SOx. Most of the fired generation capacity installed in California in the 1980s and 1990s were cogeneration units, predominately fired by natural gas, with some coal, biomass and process and landfill gas applications. Before the development of these more modern and cleaner facilities, California’s electric generation was dominated by utility-built and operated hydroelectric generation, nuclear power, and fossil fuel-fired boiler or combustion turbine systems.

The California generation system was designed to rely on an extensive, relatively inexpensive, but annually variable hydroelectric system and on imports. Prudent planning requires reserve margins to cover events like droughts, power plant forced outages, and transmission line shutdowns due to forest fires. Because facilities that are part of reserve margin are used infrequently most years, they will generally be less efficient and may not have as stringent emission controls.

The in-state fired generation can be divided into two groups. Some of these facilities, with a capacity of about 11,500 MW, operate as baseload facilities due to contractual obligations, electricity and thermal requirements of a cogeneration host, or to meet system support and reliability obligations. In general, the recent merchant-owned capacity additions and former utility-owned fuel-fired boiler and combustion turbine facilities, with a capacity of about 23,100 MW, now operate as the swing or load-following units on a daily, seasonal, and emergency basis.

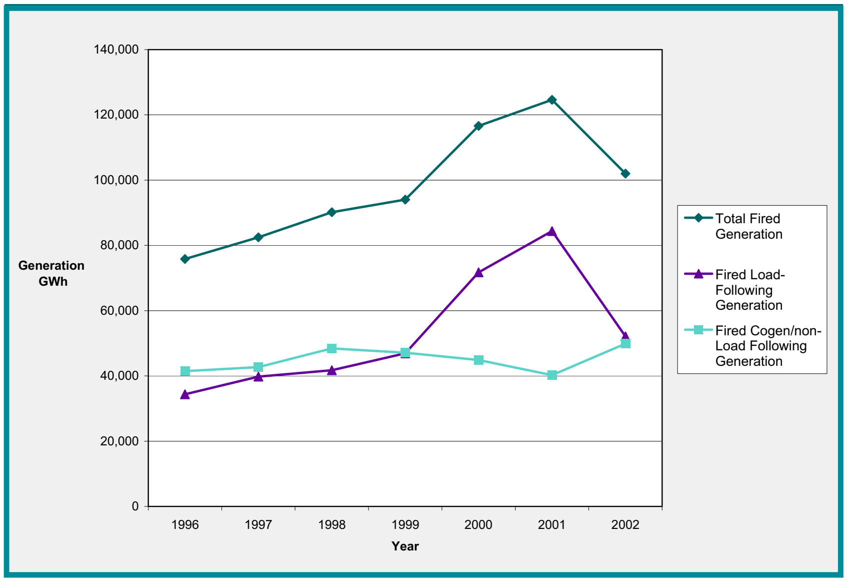
Figure III-5 shows how the in-state fired generation responded during the energy crisis. Between 1996 and 2001, the load following, or swing, portion of this generation increased its output over 50,000 GWh, more than doubling its 1996 output. Most of this increase occurred in 2000 and 2001, when these facilities increased operation to make up for the reduced in-state hydropower generation and imports. As expected, the baseload portion of the fired generation fleet had a relatively constant contribution to the in-state generation ranging from about 40,000 to 50,000 GWh per year. Other units such as wind and in-state hydro operate as often as the water or wind energy is available, and these units have little ability to increase annual generation if needed.

While the swing facilities significantly increased their generation during the crisis, their NOx emissions did not increase as rapidly. As is discussed above, the steam boiler facilities have been subject to stringent retrofit requirements, and by 2002, most of these facilities that were still operating had installed SCR. Installation of SCR typically reduced the NOx emission rate from these facilities 80 to 90 percent, from around 1.0 pounds per megawatt-hour (lbs/MWh) to between 0.1 to 0.2 lbs/MWh. In addition, beginning in 2001, new combined cycle facilities began to come online that were more efficient, and therefore likely to be dispatched more often, and significantly cleaner than even the retrofit steam boilers, with typical NOx emission rates of 0.06 lbs/MWh.

Figure III-6 shows the generation from the load following facilities and corresponding NOx emissions and emission rate. The data is from the US EPA Continuous Emissions Monitoring System (CEMS) database. Between 1996 and 2001, generation from these facilities increased almost 145 percent while NOx emissions increased only 41 percent. During this period, the NOx emission rate, shown in lbs/MWh, for these load-following units was reduced by 40 percent. By 2002, with generation returning to near 1996 levels, the NOx emission factor for the swing facilities was 50 percent less than 1996.

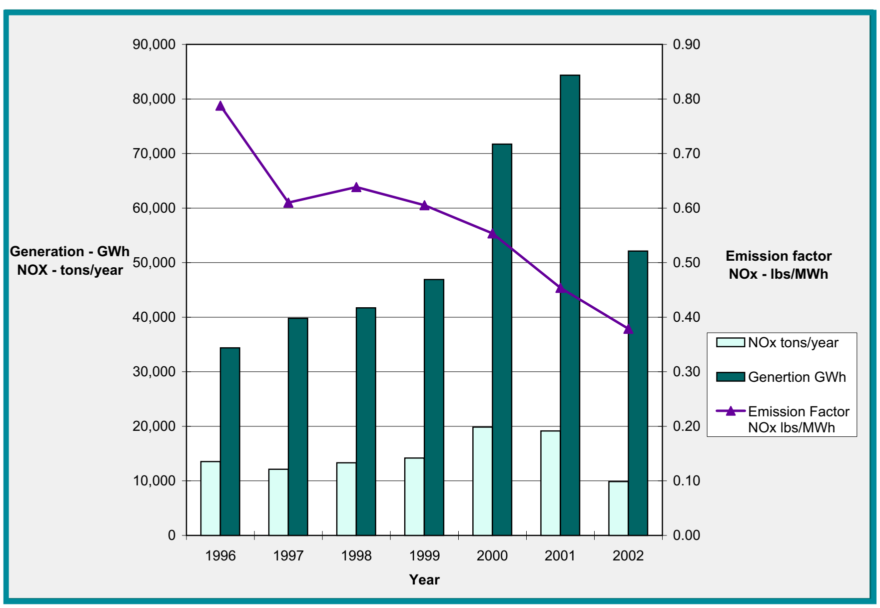
Analysis of NOx emissions for this report has focused on the swing facilities. Data for the cogeneration and base load units are inconsistent or not uniformly available, and therefore are not presented here. Alternative data sources such as the US EPA E-GRID database do not appear to reflect NOx retrofits that are knows to have occurred, and that are reflected in the CEMS data for the load following plants. However, staff assumes that the baseload facilities were not undergoing significant retrofit during this period, so their emission rates are unlikely to have changed significantly. Because their electricity generation was also relatively constant, their total emissions are believed to have remained relatively steady during this period.

Figure III-5:
Ttoal Fired and Load Following In-State Generation



- **Finding:** The load-following facilities, representing approximately 60 percent of the fuel-fired generation, achieved nearly a 50 percent reduction in average NOx emission rate. The improving NOx emission rate partially ameliorated an increase in NOx emissions during 2000 and 2001 energy crisis and reduced 2002 NOx emissions from 1996 levels.

Figure III-6:
Generation and NOx Emissions from In-state Load Following Units



PM10 Emissions 1996 to 2002

The level of PM10 emissions from fired electric generation in California depends almost entirely on the type of fuel combusted. Generation using natural gas results in very low PM10 emissions, while the use of coal and biomass can result in much higher emissions. **Figure III-7** shows the trends in PM10 emissions and emission rates for the fired portion of the state fleet using data from the US EPA's E-GRID database. While the data show a significant increase in generation, the PM10 emissions are almost flat, resulting in a decrease from 1996 to 2001 in lbs/MWh emitted. As is discussed above, this period saw a sharp increase in the natural gas portion of in-state generation. While the sharp dip in the PM10 emission rate could be a function of this natural gas-fired increase in 2000 and 2001, it is also possible that the data are incomplete or do not reflect actual emissions and control technologies.

- **Finding:** PM10 emissions rates appear to have improved between 1996 and 2002, though better data would be needed to confirm the trends.

Figure III-7:
E-GRID PM10 Emission and Emission Factor for Fired Generation

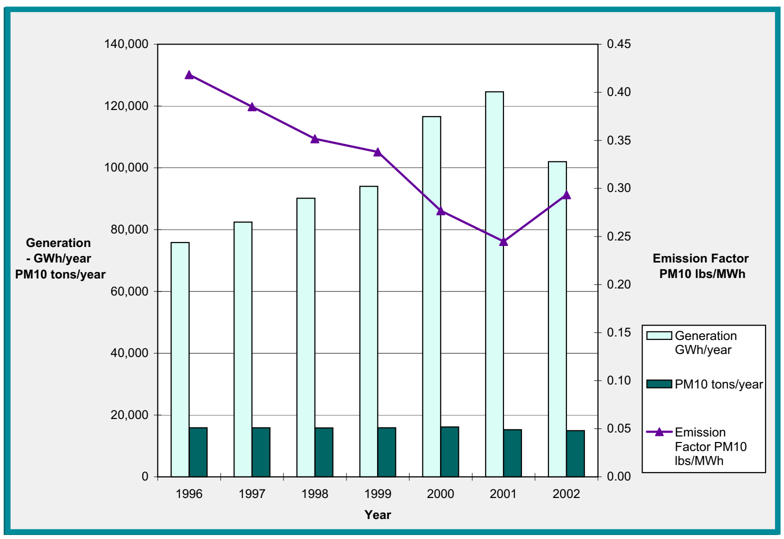
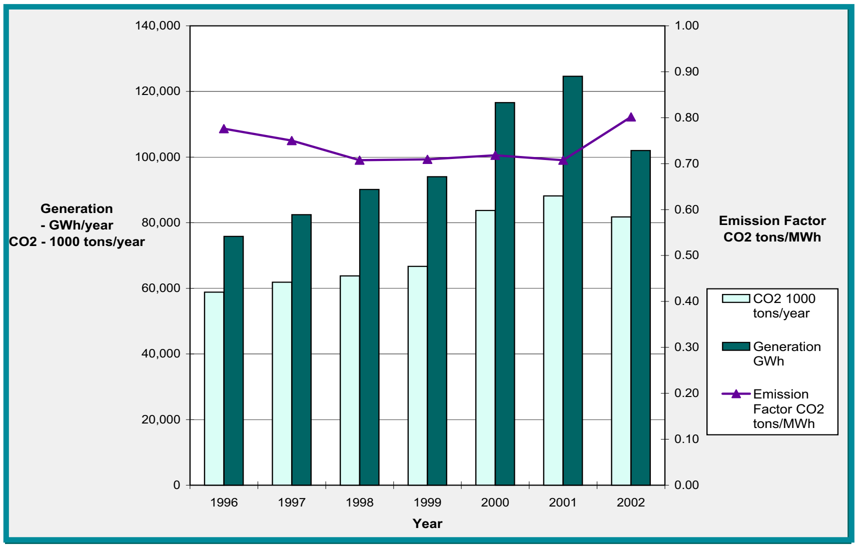


Figure III-8:
CO2 E-GRID Emissions for the In-state Fired Capacity



CO2 Emissions 1996 to 2002

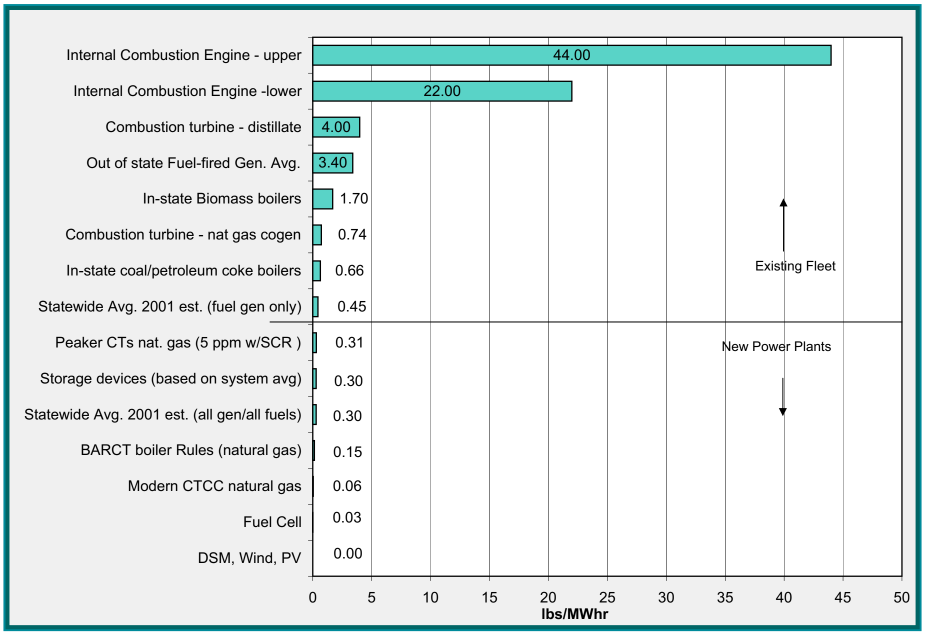
Staff examined CO2 emissions using the E-GRID database, shown in **Figure III-8**. The emissions in this figure are reported in 1000 tons, and the emission factors are reported in tons/MWh, and should not be directly compared to the emission factors for NOx and PM10, reported in lbs/MWh. The CO2 emission factors are fairly constant; and the 1999 emissions shown compare well to the 1999 Inventory (see **Table III-2**, above). The slight rise in the 2002 emission factor is due to the decrease in generation from the gas dominated load following plants and a slight increase in generation from baseload/cogeneration sector, which includes coal-fired and lower efficiency units.

Air Emissions and Regulations and the Future

Despite the energy crisis, the boom in power siting and construction, increasing population, and increasing vehicle miles traveled, California is making air quality progress in all regions, though some regions are progressing more slowly than anticipated. The progress over the years suggests a viable and robust air quality regulatory infrastructure that should provide the necessary emission reductions through new and revised rules. For example, retrofit rules targeting existing generation may be developed. New generation, under existing rules, should be more efficient and cleaner than the system averages, resulting in continued reduction in the emission factors. **Figure III-9** shows how system averages are compared to potential new additions for NOx emission rates.

- **Finding**: California needs continued air emission reductions from the generation sector. The state's air quality infrastructure can, and should, provide practical and innovative rules to address both existing and new generation sources, resulting in appropriate emission reduction contributions from the generation sector.

**Figure III-9:
NOx Emission Rates - System Averages and
Potential Resource Additions**



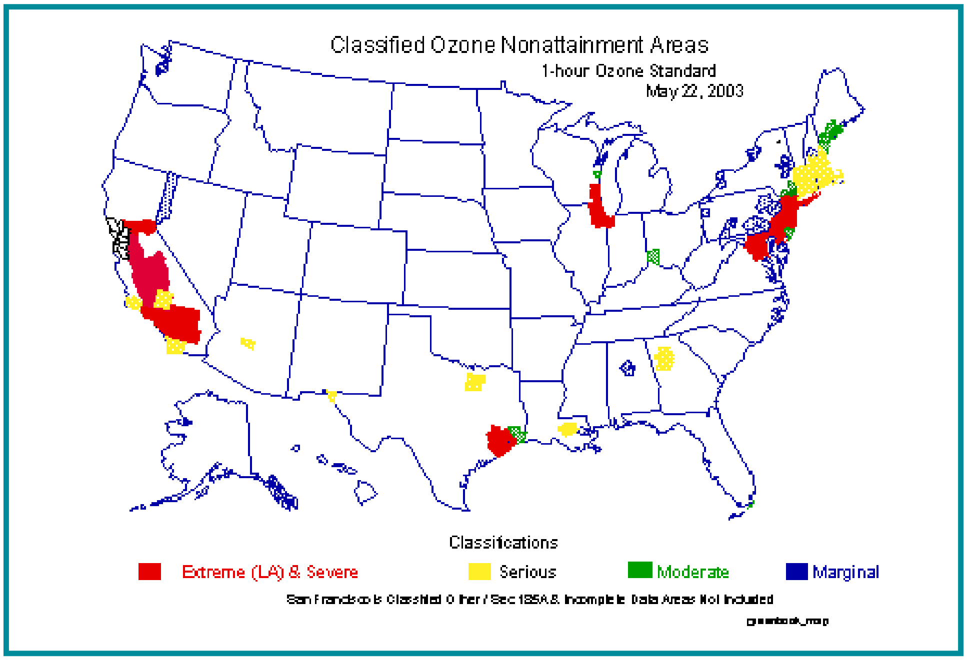
Air Emission Considerations for Imported Power

Prevailing winds and geography prevent most out-of-state generation emissions from causing impacts in California. Emissions from out-of-state fossil-fired power plants are regulated by federal rules such as those adopted to limit acid rain and potential visibility impairment on the Colorado Plateau. Additionally, most of the west outside California is attainment for federal ozone requirements, except for Reno NV and Phoenix, AZ (see **Figure III-10**). Therefore, emissions of ozone precursors (NOx and VOC) by power plants located outside of California are less likely to have significant air quality impacts. As can be seen on **Figure III-10**, large portions of California, particularly the heavily populated areas, have a serious to extreme ozone nonattaimment status, suggesting that in-state power plants emissions of ozone precursors can have a much greater air quality impact than in other areas of the west.

Similarly, PM10 nonattainment for the western United States (shown in **Figure III-11**) correlates to population centers and heavy industrial centers (*e.g.*, smelters). Again, California has large areas designated nonattainment.

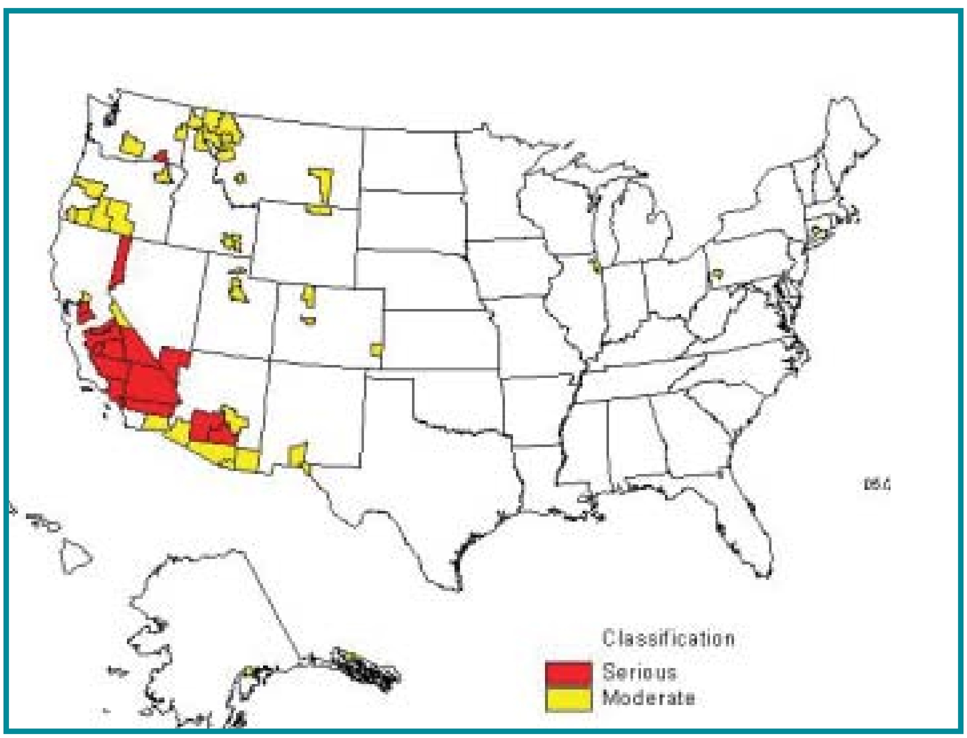
Staff has analyzed NOx emission values for the bulk of the fuel-fired power plants in the Western Electricity Coordinating Council. For almost 54,000 MW of installed, non-California, fuel-fired generating capacity, generation and NOx emissions trends from 1999 to 2002 match those seen

Figure III-10:
Classified Ozone Nonattainment Areas



Source: USEPA 2003

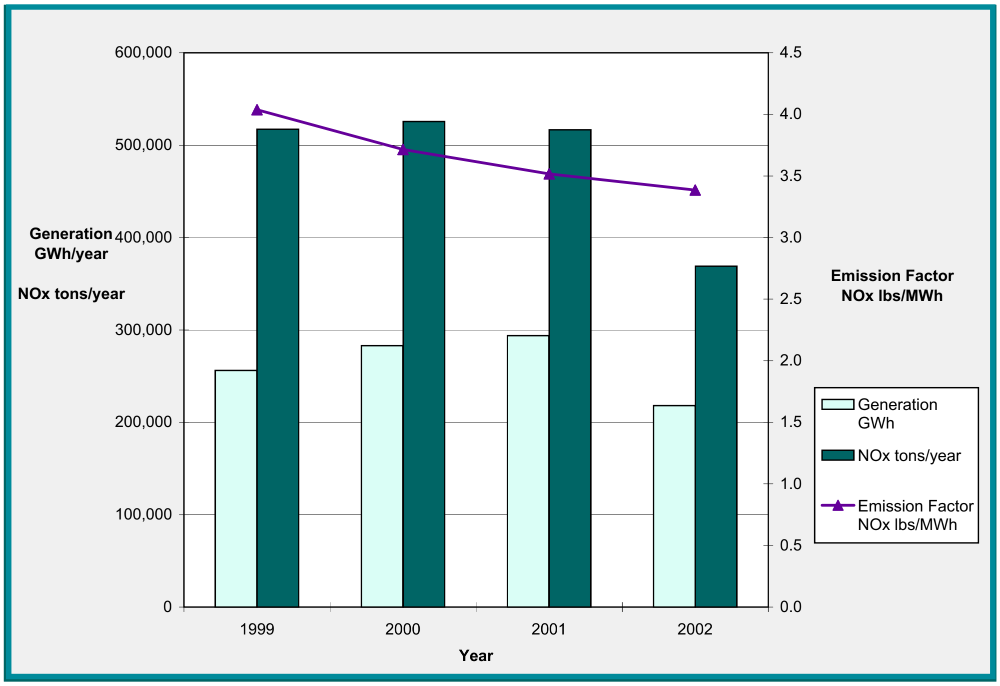
Figure III-11:
Classified PM10 Nonattainment Areas



Source: USEPA 2003

for in-state generation. Western fuel-fired generation increased in 2000 and 2001 in response to adverse hydroelectric output, resulting in a small but temporary increase in total NOx emissions, probably ameliorated by a decreasing NOx emission factor (**Figure III-12**). However, the average NOx emission rate for these out of state power plants (approximately 3.4 lbs/MWh in 2002) is almost ten times the averge NOx emission factor for California's load following capacity (less than 0.4 lbs/MWh in 2002).

Figure III-12:
WECC Fuel Fired Generation and NOx Emissions

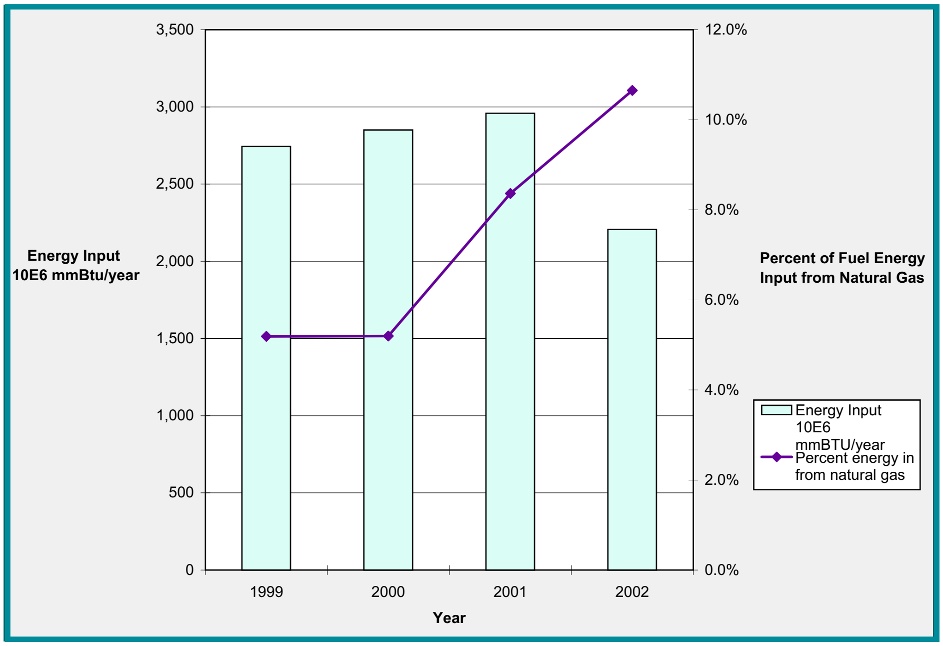


Source: USEPA 2003

The decrease in the out-of-state NOx emission factor could be attributable to an increased reliance on natural gas, as shown in **Figure III-13**, for electricity generation. However, given that the natural gas trends shown are only represented by 3 years of data (natural gas use was not reported in 1999) and during a period of significant upset in the region, this may not be a long term trend.

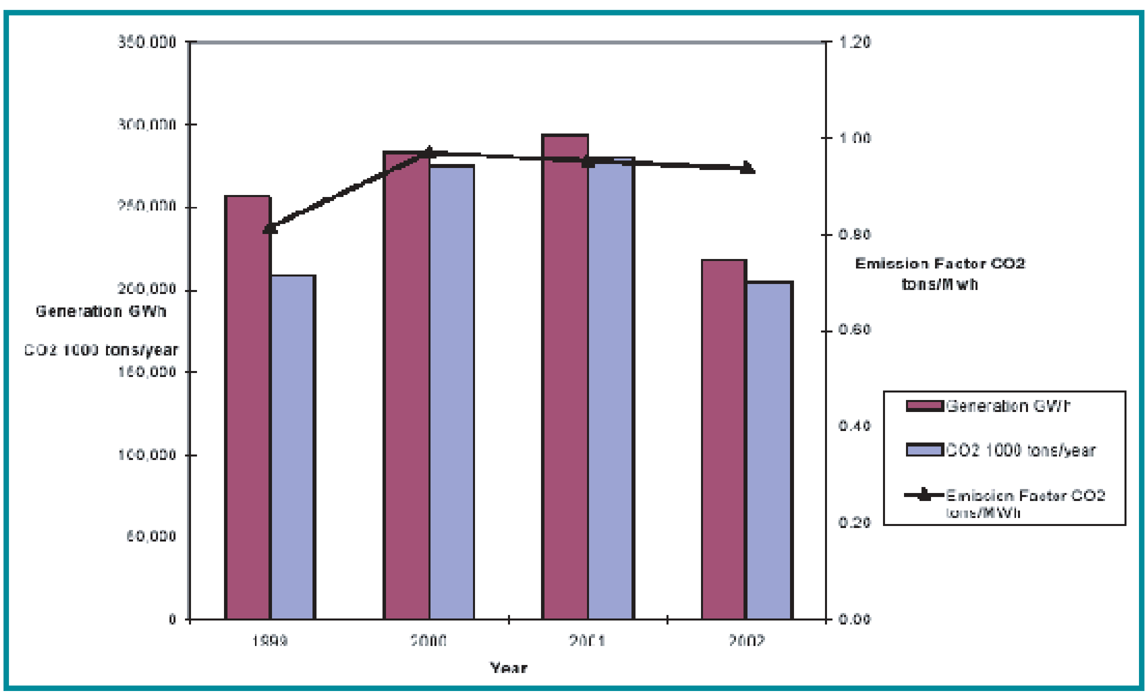
PM10 emissions and rates for out of state power plants were not collected as part of the US EPA CEMS database, and therefore are not presented here. CO2 values are shown in **Figure III-14**. The CO2 emission factor is a function of fuel type and system efficiency. Out-of-state fuel-fired generation uses much more coal and boilers than California, so the average CO2 emission factor is higher than that shown in **Figure III-8** for California. CO2 emissions from out of state generation are discussed in more detail in technical companion documents.

Figure III-13:
WECC Generation and Natural Gas Use



Source: US EPACEMS Data

Figure III-14:
WECC Generation and CO2 Emissions



Source: US EPACEMS

Because of prevailing wind patterns, the direct impacts on California's air quality from imported power will be minimal. In some instances, power plants located near the Mexican border can have some localized effects in California, including visibility impacts. Implementation of control measures on out-of-state generation, and the potential increase in the use of natural gas, may affect the availability of both electricity and natural gas for California to import, thereby affecting California generation patterns. California needs to monitor and participate in the continuing evaluation of western regional air quality and emissions by interstate organizations like the Western Regional Air Partnership.

• **Finding:** In general, imported power causes minimal air quality effects within California, except potentially near the Mexico border. Out-of-state generation appears to exhibit an improving NOx emission factor, possibly due to the increased use of natural gas. Despite NOx and CO2 emission rates being higher for out-of-state generation, significant differences in air quality settings make it difficult to predict how the plants might contribute to out-of-state air quality.

Summary of Air Emission Trends

California's relatively poor air quality is the result of complex interactions of climate, topography, and air pollutant emissions. Improvements in the state's air quality are dependent on the state's ability to control and reduce air pollutant emissions. The federal and state Clean Air Acts specify health-based ambient air quality standards and permitting programs for existing and new emission sources. These programsare designed to balance a robust economy with progress towards and maintenance of healthy air. California regulators, consumers, and businesses have cooperated to achieve steady progress in most regions. While progress is being made, in some regions it has slowed or stalled (*e.g.*, San Joaquin Valley). Districts are responding aggressively with new rules and regulations but often have had to delay the attainment date, resulting in continued exposure of the local residents to bad air quality.

Twenty-five years ago, one of the first targets of air quality regulators was the electricity generation sector. Since then, air pollutant emission reductions have been realized with increased reliance on natural gas and installation of emissions controls on most of the fossil-fueled generation resources. Also, California relies on a mix of nuclear and variable imported and hydroelectric power which cause essentially no air quality impacts in California.

California currently has an extremely low-emitting generation system. The system average NOx emission rate in terms of both total emissions and emissions per megawatt-hour decreased by more than 80 percent between 1975 and 2000, and staff expects these trends to continue. NOx emission factors for new combined cycle power plants and retrofit utility-scale boilers are 90 percent less than the system average NOx emissions rates in 2000, resulting in almost a 99 percent reduction in the NOx emission factor since 1975 (See ***2001 Environmental Performance Report***).

The magnitude of emissions from the generation system varies by air basin and by state. However, significant differences in air quality settings make it difficult to predict how the plants and their emissions might contribute to local and regional air quality. The generation system in California causes a small share of the state-wide NOx and PM10 emissions, and the contribution to NOx in particular is continuing to decrease over time. Regardless, air pollutant emission reductions from the generation sector are likely to be a valuable, but minor, component of the continued air quality improvements as cleaner generation technologies continue to be deployed and air quality rules are revised and issued. Agency coordination and research will be critical components to timely and cost effective technological advances. For example, the new combustion turbine retrofit guidance proceeding at CARB could realize emission rate improvements and emission reductions. The development of these rules, and implementation by districts, may affect the availability and cost effectiveness of these combustion turbines, suggesting the need for coordination between air agencies and electricity oversight agencies.

Environmental Performance Report
Chapter 3
Environmental Performance: Biological Resources

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Biological Resources

Summary of Findings

- **Habitat Loss:** The 18 operational natural gas-fired power plants licensed by the CEC between 1996 and 2002 caused the loss of 225 acres of habitat and produced generally minimal terrestrial biological resource impacts. Power generation development between 1996 and 2002 used approximately 3,900 total acres of land. Because California's most sensitive species tend to occupy small habitat ranges, energy development projects have the potential to cause impacts when built nearby. Use of previously disturbed lands for energy projects can minimize such effects.
- **Transmission and Pipeline Impacts:** California's 31,720 miles of electric transmission lines and 11,600 miles of natural gas pipeline rights-of-ways can contribute to habitat loss, fragmentation and degradation. Electric transmission lines can cause bird mortality from bird strikes and electrocution. Electric transmission lines can cause wildfires; between 1996 and 2002, the number of wildfires from powerlines decreased from 284 to 181.
- **Once-Through Cooling Impacts**: Twenty one natural gas and nuclear power plants totaling 23,883 MW are located on the coast or on estuaries and use hundreds of millions of gallons of water a day for once-through cooling. Impacts to marine and estuarine ecosystems from the entrainment and impingement of aquatic organisms can be significant and are an issue of concern. The repowering proposals at five coastal power plants included modern combustion turbines that meet current air emissions standards, but proposes to continue use of once-through cooling water systems.
- **Impacts from Hydropower**: Salmon or steelhead habitat is found at hydropower facilities in the Sacramento River basin, the San Joaquin River basin and on the North Coast. Very few California hydropower projects have adequate fish passage for migrating salmon and steelhead. Hydropower impacts to salmon, steelhead, native trout and other species continue to be significant. Thirty seven percent – 5,000 MW – of California's hydropower system will be relicensed by FERC between 2000 and 2015, presenting opportunities to mitigate impacts to salmonids, trout and other aquatic species.
- **Nitrogen Deposition**: Nitrogen deposition from new power plants and repower projects have potential cumulative impacts if the power plant is within the vicinity of nitrogen sensitive habitats, such as serpentine soil and desert communities. Potential nitrogen deposition impacts from new power plant proposals is emerging as an issue of concern.
- **Wildlife-Friendly Renewable Energy Production:** Few renewable energy facilities have been built since 1996, but there will be more of these facilities as utilities try to meet the Renewable Portfolio Standard. Building-integrated solar photovoltaic and turbines at landfills and sewage-treatment plants have the least risk of impacting biological resources. Other renewable energy types, such as in-forest fuels, could have wildlife-friendly benefits if biological resource protections were integrated into the planning.
- **Impacts from Wind Power:** Renewable energy from wind power will play a large role in meeting California's new Renewable Portfolio Standard. Bird mortality from strikes with turbine blades continues to be the primary biological resources issue concerning wind energy. Based on an estimate of 15,000 operational wind turbines in 2001, an estimated 488 raptors are killed annually by turbines, nearly all (96%) in California.

Introduction

Some part of California's electrical infrastructure can be found in every county. Power plants, natural gas pipelines, transmission lines, and other fuel lines are required to bring electricity to the state's ever growing population. The impacts of electrical infrastructure on biological resources include habitat loss and associated fragmentation, degradation of terrestrial and aquatic habitat, direct and indirect species fatalities, air and water pollution, and noise disturbance. The state-wide electric system is large, and what may seem to be a minor impact from a single facility can cumulatively result in a substantial loss to plant and wildlife populations or their habitats.

During review of power plant certification applications, the Energy Commission seeks ways to avoid or reduce impacts from power plant construction and operation on biological resources. Staff has identified the following key needs during the review of siting cases, and as a basis for reporting the state's electric system performance (see Appendix III-2, Data Table 1).

Key Biological Resources Needs

1. Minimizing electricity generation system effects on aquatic resources.
2. Identifying critical information and studies needed by the Energy Commission and other agencies to assess the effects of electric generation projects on biological resources and to evaluate the success of various mitigation techniques.
3. Locating new power generation facilities on sites that avoid undisturbed lands and minimize off-site impacts.
4. Meaningful research to identify and quantify where electric generation is having a detrimental or beneficial effect on biological resources and to share such research with interested parties.
5. Collaborative efforts between agencies and stakeholders on hydropower licensing, power dam decommissioning or other mitigation and restoration efforts that might change generation levels.
6. Integrated planning, permitting, inspection, and enforcement programs related to energy facilities.
7. Minimizing the potential loss of threatened, endangered, or other sensitive species and their critical habitat when constructing, operating, and maintaining facilities related to electric generation.

The **2001 Environmental Performance Report** made several findings that are still relevant to this discussion:

- Most power plants and ancillary facilities were built before environmental regulations held them to any environmental standards. As a result, many unmitigated losses have been perpetuated.
- While the majority of the original steam-powered plants were in coastal areas where once-through cooling using ocean or bay water was available, the majority of new combined-cycle plants are inland and do not use once-through cooling.
- Most of the new power plant applications are for power plants in the San Joaquin Valley, San Francisco Bay area, Los Angeles and San Diego region. Power plant development in the San Joaquin Valley has contributed to significant cumulative losses to endangered species habitats.

- The continuing use of once-through cooling at six coastal and estuarine plant sites that are being repowered will perpetuate impacts to the marine environment.
- Hydropower operations cause significant, non-mitigated impacts to aquatic ecosystems throughout California.
- Regional and county-wide Habitat Conservation Plans approved by the U.S. Fish and Wildlife Service are becoming more common and will influence the conditions the Energy Commission's places on licenses.
- The amount of habitat loss from the electric infrastructure has been low compared to that from other human impacts and land development. Oil and natural-gas-fired power plants disturb less area than renewable power facilities on a per-megawatt of capacity basis. Hydropower has a higher land impact per megawatt compared to all other generation types if reservoirs are considered to be part of the electric generation development.
- Impacts to birds from collisions with turbine blades are high in certain wind resource areas.

The following sections describe how California's electric generation and transmission systems are affecting biological resources. The first section reviews the impacts of our electric generation system on terrestrial habitats and species. The second section reviews impacts from power plants using once-through cooling technology, and recommends additional research to better understand and reduce the impacts of these facilities. The third section provides a brief overview of biological impacts from hydropower generation. The fourth section reviews the impacts natural gas-fired power plants have on sensitive plant and wildlife communities through deposition of nitrogen. Renewable technologies are reviewed in the fourth section, and a comparison of their impacts on biological resources is presented. A fifth section covers general impacts from the electric transmission line and natural gas pipeline systems. The final section reviews some of the impacts from out-of-state power facilities. Where data was available, system impact(s) since deregulation have been compared to the system before 1996.

Impacts on Terrestial Habitats and Species

Estimates of losses to California's wetlands, coastal lands, and prime farmlands due to urban development have been compiled (USDA 2000, CalEPA 2002). However, losses specific to the electrical generation sector have not been estimated, and are just now being compiled at the Energy Commission. In 1990, and estimated 8.4 million acres of private land in California was in development (CalEPA 2002). By 2002, about 10,500 acres of the state was in direct energy production, providing a total capacity of approximately 57,000 MW. Thus, electrical generation facilities account for only 0.12 percent urban development and have not resulted in large amounts of land being converted from open space into industrial development. However, energy production also uses land for fuel production and storage, or may fence off open space lands. If all energy-related reservoirs and landfills, and the open space between wind farm turbines are counted as an energy-related land use, almost 3.5 percent of the state is being used in some manner for energy production (see Appendix III-3, Note 1 and Appendix III-2, Data Table 2).

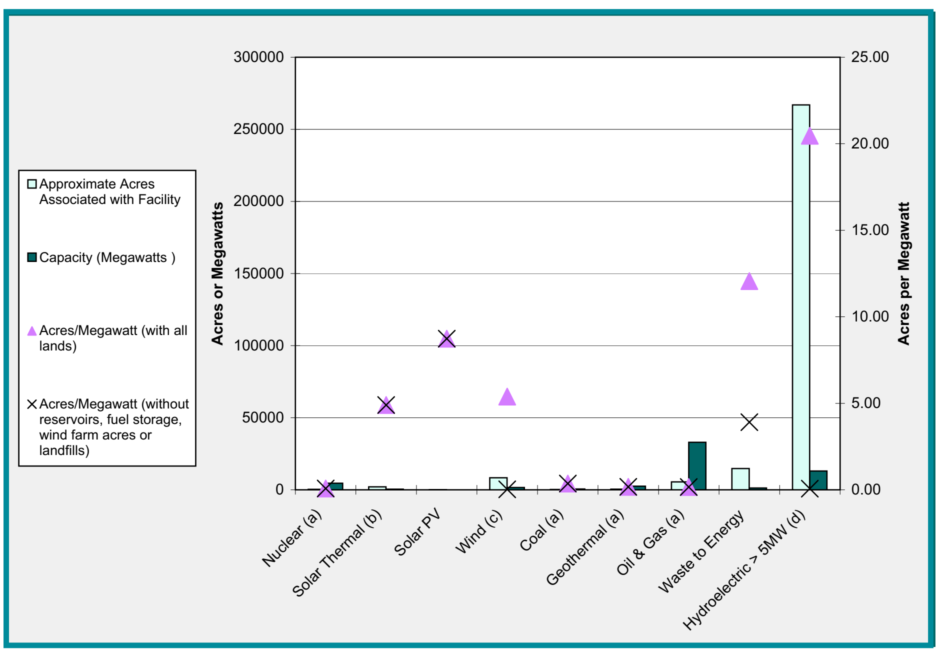
Since 1996, the state has dedicated approximately 3,900 acres of land to energy production, or 345 acres if open areas between wind farm turbines and landfills are excluded (see Appendix III-2, Data Table 2). For the eighteen projects permitted by the Energy Commission since 1996 and now in operation, there was approximately 225 acres of habitat loss (see Appendix III-2, Data

Table 3). Most of the power plants that became operational between 1996 and 2002 caused minimal biological resources impacts, but those sited in biologically rich areas or areas with many threatened or endangered species caused significant impacts which required mitigation. For example, Procter and Gamble (SMUD) and Sutter Power Project both removed vernal pools, which are home to a unique and diverse array of plants and invertebrates, and over 6.2 acres of land were placed in conservation to offset impacts. Additional data to determine the amount of land developed for fuel production (*e.g.*, natural gas and geothermal well fields) and coastal wetland losses during power plant construction between the 1930s and 1970s is being pursued for the 2005 report.

Emergency additions to California's power generation system during the energy crisis had minimal biological impact. The emergency peakers installed during 2000 and 2001 were sited on areas adjacent to existing substations (except one), and were within barren lots or on irrigated farmland measuring one to five acres (Appendix III-2, Data Table 3).

California is one of the most biologically diverse states in the nation, and many of our most sensitive species occupy small ranges that could be severely impacted by a power plant project or by a natural gas pipeline or transmission line being built nearby. However, the largest concern for most federally listed species is the cumulative habitat loss due to urban development. Efficient use of land by power production will reduce impacts to threatened and endangered species.

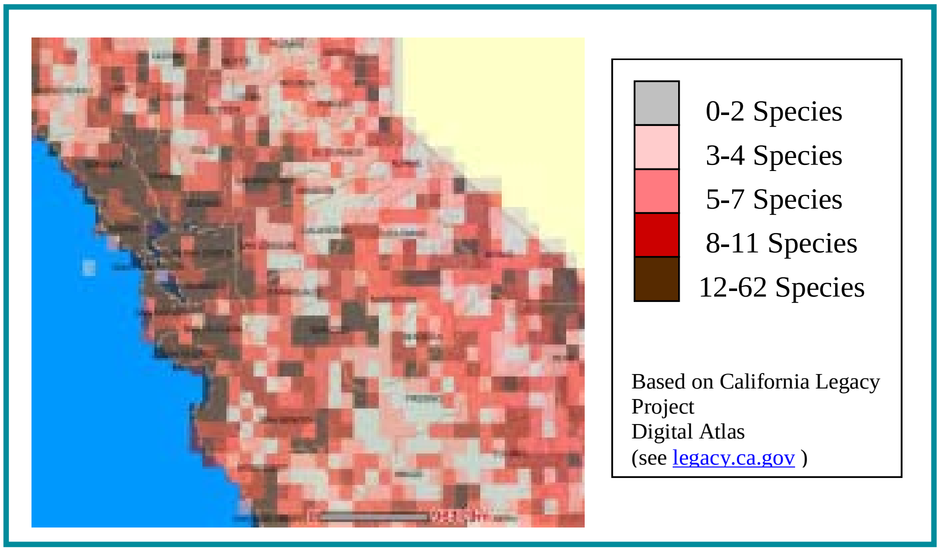
Figure III-15
Acreage, Capacity, and Number of Acres per Megawatt by Type of Power Facility for 2002



Notes:
a) Other acres outside of actual facility may be in ownership
b) Solar thermal acres account for barren areas between panels
c) Wind farms disrupt, but do not eliminate, most wildlife habitat values. Grazing is allowed below turbines when not on BLM or state park lands.
d) No data was collected for hydropower facilities under 5 MW.
e) Includes 80 percent of facilities in state (all utilities are represented)

Based on the amount of electric capacity per acre, the most efficient use of land for the production of power is natural gas, geothermal steam, coal or nuclear fission (**Figure III-15**). If all energy-related areas are taken into consideration, the least efficient use of land is hydropower, solar thermal and photovoltaics. Although hydropower reservoirs eliminated riverine, riparian and terrestrial habitats, they can provide habitat for other species of fish and wildlife. Solar photovoltaic is an inefficient use of land, but when placed in existing urban areas, it is a wildlife-friendly power source and is unlikely to impact sensitive species. Wind farms and landfills can still be used by wildlife (with some exceptions), so they can be efficient and wildlife-friendly power production. Directing future development of energy facilities to previously disturbed lands can reduce habitat losses to many of our rare, threatened and endangered species.

Figure III-16
Areas with High Numbers of Listed Sepcies in Central California



Most gas-fired and renewable power plants (excluding hydropower) are located in urban and agricultural areas or in grasslands [1]. Most hydropower facilities are in woodland and forest areas since they are in the higher elevations of the Sierra Nevada Mountains (Appendix III-2, Data Tables 4 and 5). While the number of power plants has increased since 1996, the vegetation communities that surround power plant development are still predominantly urban and agricultural. Indeed, power plant construction within urban and agricultural areas are on the rise, which shows progress in reducing impacts on undisturbed lands. However, rare, threatened, or endangered species can live in agricultural areas, and many urban areas (such as San Francisco peninsula) have high numbers of listed species (**Figure III-16**). Thus, the selection of a power plant site or a transmission line or natural gas pipeline route should not only consider if the land is disturbed, but also consider the probability of impacting a sensitive species. By directing future development of

[1] The database query used the California GAP Analysis (1998) project which derived communities from photointerpretation of 1990 Landsat Thematic Mapper digital images, supplemented by 1990 National High Altitude Aerial Photography Program photography. The data may contain some large scale vegetation maps from the 1980s (Sierra Nevada) and 1970s (desert communities). Holland (1986) and California Wildlife Habitat Relationships (CWHR) vegetation types are both used in this report.

energy facilities to areas with few threatened or endangered species, impacts to sensitive biological resources can be avoided or minimized.

- **Finding:** Many of California's most sensitive species occupy small ranges that could be severely impacted if a power plant project or by a natural gas pipeline or transmission line were built nearby. However, by far the largest concern for federally listed species is cumulative habitat loss due to urban development. Energy development will minimize impacts when built on previously disturbed lands and areas with few rare species.

The number of federally listed species and the number of critical habitat designations increased from 190 in 1996 to over 380 in 2002. The majority of California's operational power plants (564 out of 1,052 facilities) are oil- and natural gas-fired facilities and small (<5 MW) hydropower facilities. Almost all of the oil- and natural gas-fired facilities (317 out of 346) and small hydropower facilities (215 out of 218) were built prior to 1996 (Appendix III-2, Data Tables 4 and 5). Because of the large number of oil- and natural gas-fired and small hydropower facilities and their occurrence throughout the state, they have a high probability of impacting a federally-listed species. Indeed, small hydropower had the highest potential to impact federally-listed species when compared to other renewable generation technologies, followed by wind and biomass from digesters or landfills (Appendix III-2, Data Table 6). Because so few power plant facilities of any type have been built since 1996, few federally listed species or their critical habitat have been impacted by recent power plants in comparison to the pre-1996 facilities.

To offset habitat loss from power plant and associated linear facilities development, habitat compensation and restoration is often required. The Energy Commission requires habitat compensation and suitable endowments for fully mitigating impacts to California's natural resources in its licensing review. Staff will continue to map and collect data on energy-related mitigation lands to judge the performance of our permitting process (Indicator BIO1).

- ***Indicator BIO1:*** Track the number of habitat compensation sites that are attributable to Energy Commission projects. Track the habitat type and quality of compensation sites to ensure Energy Commission projects have improved native vegetation and/or wildlife species habitat.

One of the more recent trends for habitat compensation is to address urban development on a regional scale using Habitat Conservation Plans or Natural Communities Conservation Plans (Conservation Plan; see Appendix III-2, Data Table 8). When proposed power plants are within the boundaries of a Conservation Plan, applicants have the option of purchasing Conservation Plan credits to offset impacts or use either a mitigation or conservation bank (See Appendix III-3, Notes 3 and 4). For example, the Tracy Peaker Power Plant Project (01-AFC-16) offset impacts to San Joaquin kit fox and the Inland Empire Energy Center (01-AFC-17) is proposing to offset impacts to Stephen's kangaroo rat through purchase of Conservation Plan credits. The Energy Commission does not advocate a certain strategy for its applicants to use when providing habitat compensation as long as habitat loss is mitigated, and an endowment account is set up to manage the land in perpetuity.

As urban development continues, good quality habitat is more difficult to find and acquire at a reasonable cost and parts of the state have no habitat compensation lands available. Because the Energy Commission has always required full mitigation for habitat losses, this can be a limiting factor when proposing a power plant, so staff will track this trend through Indicators BIO2 and BIO3. For example, in Santa Clara County habitat compensation for burrowing owls, a state species of special concern that is proposed for state listing, is not available because all suitable land for nesting burrowing owls has been approved for development or is City-owned. Therefore, projects in Santa Clara County that remove burrowing owl habitat have a significant unmitigable impact and additional facilities in this county may become difficult to permit if they directly impact burrowing owls.

- ***Indicator BIO2:*** Assess the availability of private mitigation banks and highlight those areas where mitigation lands are scarce for specific species and habitats.
- ***Indicator BIO3:*** Determine which ecosystems have disproportionately high losses for specific species and habitats in order to improve the review of siting cases.

Once-Through Cooling Impacts on Aquatic Biological Resources

Once-through cooling facilities withdraw cooling water from a river, stream, lake, reservoir, estuary, ocean, or other waterbody and return the used water to the source. The withdrawal of large volumes of cooling water (up to 2.5 billion gallons per day) [2] affects large quantities of aquatic organisms annually through impingement or entrainment[3]. Species impacted include phytoplankton (tiny, free-floating photosynthetic organisms suspended in the water column), zooplankton (small aquatic animals, including fish eggs and larvae, that consume phytoplankton and other zooplankton), fish, crustaceans, shellfish, and many other forms of aquatic life. There can be large losses from just one operating power plant. For example, at Diablo Canyon Power plant (California Regional Water Board 2000), the proportions of larva lost for five selected nearshore fish are 10 to 30 percent.

Diablo Canyon Power Plant is used as an example of impacts from a once-through cooling plant because it has recently undergone review for renewal of its cooling water system permit and, consequently, has current, in-depth scientific analyses. The power plant with the largest once-through cooling impacts is unknown because such data is not generally required or available.

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[2] For example, Diablo Canyon Nuclear Power Plant circulates up to 2.5 billion gallons of water each day.

[3] During operation, impacts to the aquatic environment occurs when aquatic organisms are *impinged on* (trapped against) components of the cooling water intake structure or *entrained in* (drawn through) the cooling water system itself. Impinged organisms can experience starvation, exhaustion, and asphyxiation. Entrained organisms are subject to mechanical, thermal, and/or toxic stress when they travel through pumps and cooling structures; this often results in very high mortality rates.

Cooling Water Withdrawal

In California, 21 operating power plants utilize once-through cooling and are permitted to pump hundreds of millions of gallons of water each day. Of these, more than half are located along the Southern California coast; nearly three quarters have shoreline intakes and/or outfalls; only about one third have offshore intakes and outfalls; and more than half have their intakes and/or outfalls

	MW Capacity	Intake Location	Outfall Location	Permitted Water Volume (mgd)
North Coast				
Contra Costa	680	Shoreline[4], San Joaquin River delta	Shoreline river	341
Humboldt Bay Thermal	135	Shoreline, Humboldt Bay	Shoreline bay	78.3
Hunters Point	215	Shoreline, San Francisco Bay	Shoreline bay	412.3
Pittsburg	2,029	Shoreline, San Joaquin River delta	Shoreline river	1,000
Potrero	362	Shoreline, San Francisco Bay	Shoreline bay	111.1
Central Coast				
Diablo Canyon Nuclear	2200	Shoreline cove	Shoreline cove	2,540
Mandalay Bay	570	Shoreline, Channel Islands Harbor	Shoreline canal	255.3
Morro Bay	1,056	Shoreline, Morro Bay Harbor	Shoreline canal	725
Moss Landing	2,538	Shoreline, Moss Landing Harbor	Offshore[4]	1,224
Ormond Beach	1,500	Offshore	Offshore	688.2
South Coast				
Alamitos	2,083	Shoreline, Alamitos Bay channel	Shoreline, flood channel	1,283
El Segundo	1,020	Offshore	Offshore	607
Encina	1,000	Shoreline, Agua Hedionda Lagoon	Shoreline channel	863
Haynes	1,570	Shoreline, Long Beach Marina	Shoreline, San Gabriel River	1,014
Huntington Beach	788	Offshore	Offshore	516
Long Beach	577	Shoreline, Long Beach Harbor	Shoreline, Long Beach Harbor	265
Los Angeles Harbor	472	Shoreline, Los Angeles Harbor	Shoreline, Los Angeles Harbor	170
Redondo Beach	1,310	Offshore	Offshore, King Harbor	898
San Onofre Nuclear	2,254	Offshore	Offshore	2,605.5
Scattergood	818	Offshore	Offshore	496
South Bay	706	Shoreline, San Diego Bay	Shoreline, San Diego Bay	602
Totals	**23,883**			**16,694.7**

mgd = million gallons per day

Table III-3: Location of Intake and Outfall Structures at Once-Through Cooling Facilities

[4] A "Shoreline" intake or outfall is located in shallow water of the Pacific Ocean shoreline or the shoreline of a harbor, channel, bay, lagoon, cove, river, or canal. An "Offshore" intake or outfall is located hundreds or thousands of feet offshore in deeper water of a bay or the Pacific Ocean.

located within closed or somewhat closed system such as a harbor, bay, cove, river or estuary (**Table III-3**). Overall, intakes/outfalls located in fairly closed systems such as a bay or estuary are more likely to have significant entrainment impacts than similar intakes located in an open system such as the Pacific Ocean. However, intake on an open coast can also have large entrainment impacts (see Appendix III-3, Note 5). The completion of recent site specific entrainment and impingement modeling is an essential part of impact analysis for all new power plants and repower projects under Commission jurisdiction if the proposed project is using once-through cooling.

No once-through cooling power plants have been built in new locations within California since the 1970s, so there is no comparison between the current market and the regulated market. However, the Commission has recently reviewed five Applications for Certification (AFC) for repowering or modernization (**Table III-4**). The current trend is to replace turbines and other land facilities, but retain once-through cooling intakes and outfalls. Regional Boards have not been requesting changes to the intake or outfalls during these siting cases. Of the five once-through cooling power plant projects that filed an AFC since 1996, three are still pending, and two projects (Moss Landing Modernization and Huntington Beach Retool Project) have been licensed, constructed and are operating. Only one project did not complete an impingement/entrainment study (**Table III-4**). Commission staff did not complete a cooling alternative analysis for the Huntington Beach Retool project because the Commission license process was concluded very quickly (~2 months) under a Governor’s Emergency Order due to the anticipated energy crisis for the summer of 2001.

Project/ AFC Number	Project Status as of May 2003	New Intake or Discharge?	Cooling Alternatives Anyalzed?*	Impingement /Entrainment Study Completed?
Moss Landing Modernization (99-AFC-4)	Operating	No	Yes	Yes
Potrero Unit 7 (00-AFC-4)	Evidentiary hearings on-going	Yes	Yes	Yes
Morro Bay Modernization (00-AFC-12)	Evidentiary hearings completed and a proposed decision is published	No	Yes	Yes
Huntington Beach Retool (00-AFC-13)	Unit 3 is operating	No	No	No**
El Segundo Redevelopment (00-AFC-14)	Evidentiary hearings completed	No	Yes	No

* Cooling alternative methods include dry cooling, use of recycled water for cooling, or other land-based cooling

**The Huntington Beach 316(b)-like study will begin Spring 2003 once the project begins commercial operation and is expected to be completed by Fall 2004.

Table III-4: Status of Once-Through Cooling Facility Permits for Intake Structures

Water use and discharge in California is administered by Regional Boards in accordance with Section 316(a) and (b) of the federal Clean Water Act. The Regional Boards issue a National Pollutant Discharge and Elimination System (NPDES) permit to applicants (dischargers). The NPDES permit sets water volume limits for each intake/discharge. The U.S. Environmental Protection Agency, which administers Section 316(b), has begun to develop new regulations due to legal challenges related to impingement and entrainment impacts of cooling water intakes. Overall, the trend in 316(b) regulations for new intakes is to establish national intake and velocity requirements as well as location-based requirements to minimize impingement and entrainment impacts. Staff will continue to monitor this trend (Indicator BIO 4).

- ***Indicator BIO4:*** Compile and analyze any completed studies of entrainment/impingement impacts for once-through cooling power plant facilities and make them available for review.

Thermal Discharges

California has more power plants discharging into salt and brackish water than any other state (Leef *et al.* 2001). Permitted cooling water discharges often result in the release of water that is 30 degrees Fahrenheit (ºF) or more above that of the receiving water. Impacts from heated water discharges can vary depending upon the species present and location of the discharge structure. Heated discharge into environments that normally experience wide temperature ranges during tidal

Impacts of Thermal Discharges on Biological Resources; A Case Study of South Bay Power Plant, San Diego Bay, San Diego County

The South Bay Power Plant withdraws its cooling water from, and discharges its heated cooling water into, the southern end of San Diego Bay. The south bay environment is the most vulnerable in summer because of naturally high water temperatures. Yet in summer the power plant releases the most thermal pollution (the warmest water) because of higher energy demands. Water temperatures discharged from the power plant can be over 100 ºF, a lethal temperature for fishes, shellfish, and other marine life. In addition to heat, the power plant releases toxic chemicals in its discharge water, including copper, zinc, nickel, and chromium (primarily from corrosion in the condenser and condenser tubing), and chlorine. Studies have shown that the high temperatures make the effect of these chemicals even more toxic to marine life. Higher water temperatures also reduce the amount of oxygen in the discharge receiving water which then increases the metabolic rates of animals and their oxygen demand. Thus, animals have an increased need for oxygen, but there is less available in the water.

Biologists also believe that the ecosystem of the south bay is less diverse because of the power plant since the dominant species are only those that can withstand the higher water temperatures. Biologists have found that the diversity of benthic (bottom dwelling) marine life is significantly reduced in the south bay in areas directly affected by the power plant's discharge.

(San Diego Bay Council 2001).

and annual cycles (*e.g.* estuaries) are more resistant to changes from thermal effects than those that do not normally experience such changes. Power plant discharges can result in decreased species diversity and density of species at the community and ecosystem levels.

Thermal impacts to sensitive species and species in decline are of particular concern to resource agencies trying to protect these species. Thermal discharges close to shore can also impact our state's shoreline. For example, Diablo Canyon's discharge continuously affects 2.2 kilometers of the shoreline and occasionally affects an additional 1.2 kilometers of shoreline, in addition to impacting adjacent kelp beds (Tenera 1997 and 2002).

Availability of Alternatives

Because the impacts of once-through cooling are well documented, Commission staff have completed detailed power plant cooling alternative analyses for four of the five once-through cooling power plant siting cases to determine if avoidance was possible. For these four siting cases, Commission staff determined that one or more alternative cooling methods (*e.g.* dry cooling, use of recycled water) were technically feasible and would result in few if any terrestrial biological resource impacts. Applicants have disputed staff's findings that particular projects could feasibly be modified to include alternative cooling. One feasibility of alternative cooling has been a disputed issue in these cases. While alternatives to using sea and estuary water for power plant cooling are available, owners continue to propose projects that use once-through cooling because it is economically attractive.

The State Water Resources Control Board Resolution 75-58 suggests that ocean water is preferred over fresh water for power plant cooling. However, the State Water Resources Control Board also states that an analysis of water supply alternatives should be completed for each project, and that they are encouraged by the number of plants using reclaimed water, dry cooling and other water conserving technologies (Baggett 2002).

- **Finding*:*** The results of a recent (no more than 2 years old) project-specific entrainment and impingment study from the local source water are essential for siting of new power or repower projects which propose to use, or are already using, once-through cooling. Entrainment and impingement impacts can be avoided only with alternative cooling methods such as dry-cooling or the use of reclaimed water.

Hydropower Impacts to Biological Resources

As described in the ***2001 Environmental Performance Report***, hydropower can cause significant impacts to aquatic ecosystems in rivers and streams by changing natural river flows, dewatering river sections, changing water temperatures, changing channel structures and blocking passage of ocean-going fish (salmonids) and resident trout populations. Nearly all of California's major waterways have hydropower facilities on them. The greatest number of hydropower facilities have been constructed in the Sacramento River watershed region (85 facilities), followed by the San Joaquin River watershed region (56; **Table III-5**). A majority of the hydropower facilities potentially impact sensitive species (Appendix III-3, Note 9). Three regions (North Coast, Sacramento River, San Joaquin River) have facilities that affect migrating salmon and steelhead (**Table III-5**).

Because most hydropower development projects in California were not required to construct fish bypass facilities, fish movement to historic spawning areas were blocked (NMFS 1996). For example, all the facilities in the North Coast Region block migrating salmon and steelhead. Methods used to increase fish passage have met with limited success. The controversy surrounding migrating salmon and steelhead has created fierce legal battles and lengthy consensus building processes (Appendix III-3, Note 10). Many issues, such as the need for downstream infrastructure improvements, have delayed implementation of restoration efforts in many watersheds. How-

Watershed Region	# of Hydro Facilities	% of Total # State Hydro Facilities	Main River Systems	% of Facilities with Records of Sensitive Species Presence *	% Facilities within Region with Potential for Salmon or Steelhead	# of Unique Sensitive Species Records
Sacramento River	85	36.2%	Sacramento, American, Bear, Pit, McCloud, Feather, Yuba	61.2%	24.7%	34
San Joaquin	56	23.8%	San Joaquin, Merced, Mokelumne, Tuolumne, Stanislaus, Calaveras	55.4%	19.6%	27
Colorado River	25	10.6%	Colorado	52.0%	0	27
South Lahontan	25	10.6%	Owens	44.0%	0	12
South Coast	16	6.8%	Ventura, Santa Ana, San Gabriel	93.8%	0	11
Tulare Lake	15	6.4%	Kern, Kings, Kaweah	80.0%	0	17
North Coast	11	4.7%	Klamath, Russian, Trinity	81.8%	100%	9
North Lahontan	2	0.85%	Truckee	No Records	0	No Records

*-California Natural Diversity Database was queried for an 800 meter circumference around power plant facility and unique occurrences tabulated

Table III-5: California Hydropower Facilities with Potential for Impacts to Sensitive Species and Andromous Fish

ever, despite the loss of most migrating salmon and steelhead habitat due to dams, there are still opportunities to restore relatively long reaches of contiguous habitat as the following examples illustrate:

- **Battle Creek System (37.9 MW):** Pacific Gas and Electric, state, and federal agencies formed a Memorandum of Understanding to restore salmon and steelhead spawning habitat on Battle Creek, which is a tributary to the Sacramento River. The preferred alternative includes removal of dams and the transfer of associated water rights for instream use (USFWS 2000). Approximately 42 miles of salmon and steelhead habitat would likely benefit from the Battle Creek Restoration project.

- **South Yuba River (50 MW):** The lower Yuba River upstream to Englebright Dam was recently designated as critical habitat for the Central Valley steelhead and the spring run chinook salmon (USFWS 2000a and 2001). Approximately 50 miles of contiguous fish habitat upstream of Englebright Dam have restoration potential for the federally threatened spring run chinook salmon and Central Valley steelhead. Englebright Dam has no fish passage facilities and blocks salmon and steelhead migration to the north, middle, and south Yuba Rivers. Operation of the hydropower facilities at Englebright also strand spawning chinook salmon below the dam due to fluctuating water levels associated with hydropower production changes (CDFG 2001). Although removal of the dam would likely improve instream flows and fish passage, substantial restoration work would also be needed upstream. Contaminated sediments and erosion control are two issues that would need to be addressed. Nevertheless, it is likely that restoration of the system would provide additional spawning habitat for listed salmon and steelhead.

Consensus Difficult to Reach in Hydropower Restoration/ Conservation Efforts.

Attempting restoration of watersheds affected by hydropower generation has been difficult. How water will be allocated, and what the impact will be to the electricity supply and multiple users are often key issues when attempting to restore biological communities affected by hydropower generation. Four key projects have struggled to find a balance on this issue.

The ***Klamath Project*** generates electricity and provides irrigation water to farmers in California and Oregon. Wildlife refuges in the Klamath Basin also depend on water from the Klamath Project. To provide water for consumptive uses, construction of Copco Dam blocked access to historical salmonid spawning and rearing habitat in California (NMFS 1996). Instream flow issues for Klamath Project operations are ongoing and fish kills were documented on the river in 1994, 1997, 2000, and 2002 (USFWS 1997, CDFG 2003). The project is now in litigation over issues to protect/enhance biological resources and other competing interests.

The ***Trinity River Diversion*** eliminated approximately 109 miles of salmon and steelhead habitat. Section 2 of the 1955 Act authorizing Trinity River Diversion construction directed the Secretary of the Interior to ensure the preservation and propagation of fish and wildlife in the Trinity Basin through the adoption of appropriate measures. However, measures meant to protect the resources were not maintained, and within a decade, salmon and steelhead populations began to decline. A series of decisions and congressional acts, have since complicated the situation. The project is currently under litigation over issues to protect/enhance biological resources and other competing interests.

The ***Mokelumne River*** and ***Rock Creek*** (North Fork Feather River) projects are examples of projects that reached a consensus, although it took some time for this to occur. Both reached relicensing settlement agreements in 2000 as the result of negotiations between PG&E, state and federal agencies, and public interest groups. Both agreements included increased downstream flows to increase recreational opportunities and protect/enhance biological resources. (See also Appendix III-3, Note 10)

From 2000 to 2015, 44 California hydropower facilities will need to renew FERC licenses. Most facilities currently operating have unscreened diversions and no fish passage provisions. Entrainment of fish or other aquatic resources by unscreened diversions can adversely impact biological resources. Where applicable, the National Marine Fisheries Service now routinely seeks provisions for fish passage, screened diversions and modified instream flows (Edmondson 2003). When the State Water Resources Control Board issues a 401 Certification as part of the FERC license, the Board sometimes includes water quality conditions, including instream flow thresholds to benefit fish (Canaday 2003). In addition to supporting other resource agencies in reducing impacts to aquatic resources caused by hydropower operations, staff will track research and technology that addresses ways to reduce hydropower impacts to aquatic resources (Indicator BIO5).

Although mitigation and restoration efforts associated with hydropower facilities can focus on salmon and steelhead, California also supports the richest diversity of native trout species in the nation. Of the 11 species of native trout supported by California waters, the Lahontan, Paiute, and Little Kern Golden trout are listed as federally endangered. Using its authorities under section 10(j) of the Federal Power Act, the Department of Fish and Game works to reduce and mitigate hydropower impacts to California's wild trout fishery during hydropower relicensing proceedings. These efforts include recommendations to protect the wild trout fisheries at Hat Creek, the Kern River, the Feather River and the Mokelumne River. A recently enacted (AB 2013) will provide additional support for the Department of Fish and Game Heritage Trout Program. Besides potential impacts to native trout, the Department of Fish and Game also works to protect and enhance habitat for amphibians, such as the endangered foothill yellow-legged frog, and other state-listed aquatic and terrestrial species.

- ***Indicator BIO5:*** Track the number of hydropower facilities required to provide fish passage, modified instream flows, adaptive management, and/or fish screens during permitting by other state and federal agencies.

- **Finding:** A significant amount of hydropower capacity will be up for relicensing in the next 15 years.

Nitrogen Deposition Impacts on Biological Resources

Since the U.S. Forest Service developed guidelines to assess the effects of air pollution on wilderness resources in 1992 (Peterson *et al.*1992), the Energy Commission has seen an increased interest from federal land managers about potential air pollution impacts from proposed power plants. The most common concern has been about nitrogen (in the forms of NOx, NO2, and ammonia), which can fall to the earth as either wet or dry deposition[4]. In areas where nitrogen deposition is known to be high, federal land managers are particularly concerned about projects that could increase existing pollution levels. For example, staff at Joshua Tree National Park has evaluated nitrogen deposition from two proposed power plants within 50 miles of the Park. In addition to impacting federal lands, nitrogen deposition can also impact sensitive plant and animal

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[5] Atmospheric deposition occurs in two forms: when polluted water droplets fall out of the atmosphere (wet deposition) or when nutrients scatter as dust and particles or as aerosols (dry deposition)

communities, and the U.S. Fish and Wildlife Service has begun evaluating potential nitrogen deposition impacts to federally listed species. The Energy Commission expects power plants in air basins high in nitrogen to undergo more scrutiny for potential impacts.

As identified in the AIR QUALITY section of this chapter, 3,038 tons of NO_x per day were emitted in the state in 2002, of which 3.0 percent (92 tons per day) was attributed to thermal power generation (**Table III-1**). Despite being a small contributor in the state, a power plant in a nitrogen sensitive location can have a large impact on local biological resources. A brief overview of the identified deposition impacts from in-state power generation are presented below.

Terrestrial Nitrogen Deposition

Nitrogen is the primary limiting factor for plant growth in nitrogen poor soils. When introduced into these habitats through deposition, it acts as a fertilizer and makes it easier for non-native weedy species to invade and out-compete the native plant species. This can result in a loss of native plant and animal diversity in desert, coastal sage scrub, and serpentine soil areas (Fox *et al.* 1989; Blanchard *et al*. 1996, ESA 1999, Weiss 1999).

In nitrogen-stressed ecosystems (one where ambient conditions are high and soils are already nitrogen saturated or are naturally nitrogen limited), applicants to the Energy Commission licensing process were required to model their potential impacts and then provide mitigation for cumulative NOx impacts. As an example, in Santa Clara County the federally endangered bay checkerspot butterfly has been affected by changes in the environment from nitrogen deposition on serpentine grasslands habitats (Weiss 1999). During the Metcalf Energy Center (99-AFC-3) and Los Esteros Critical Energy Facility (01-AFC-12) certification review, the applicants were required to provide modeling scenarios. The results showed that power plant emissions could impact habitat for the bay checkerspot butterfly. Habitat compensation and funding for land management to benefit the butterfly were required in both cases. More research is needed to identify impacts and to propose adequate mitigation (Indicator BIO6). Nitrogen deposition modeling is an essential part of impact analysis for all new power plants and repower projects under Commission jurisdiction if the proposed project is within the vicinity of nitrogen sensitive habitats.

- ***Indicator BIO6:*** Inventory potentially nitrogen-limited and nitrogen-saturated habitats in the state and track results of research on these habitats.

- **Finding*:*** Nitrogen deposition from new power plants and repower projects under Com mission jurisdiction have potential cumulative impacts when the power plants is within the vicinity of nitrogen sensitive habitats, such as serpentine soil and desert communities. Developing appropriate mitigation requires project-specific nitrogen deposition modeling.

Nitrogen Deposition on Coastal Waters

Even though runoff from agricultural and urban areas may be the largest source of non-point[5] pollution, growing evidence suggests that atmospheric deposition, particularly nitrogen, may have a significant influence on nutrient enrichment in water bodies. Excess nitrogen is a significant estuarine pollutant, often leading to water quality problems such as poor water clarity, low levels of dissolved oxygen, and harmful or toxic algal blooms. In California, the EPA has targeted Morro Bay, San Francisco Estuary, and Santa Monica Bay as high-priority estuaries for pollution planning. In Morro Bay and San Francisco Bay, total pollutant loading from the atmosphere is relatively small compared to point and other non-point pollutant sources (San Francisco Estuary Project 1992, Morro Bay Estuary 2000). Los Angeles is still collecting data for Santa Monica Bay. Because power plants contribute nitrogen to the atmosphere, staff proposes to continue to track the status of research and to sponsor independent research where feasible (Indicator BIO6).

Impacts of Renewables on Biological Resources

California recently adopted a new Renewable Portfolio Standard that set mandatory goals for utilities to increase the amount of renewable technologies within their power mix (SB 1078). The biological resource impacts of renewable technologies vary depending on location and on the number and rarity of listed species in the local area (see **Figure III-16**). Renewable energy facilities, just like non-renewables, have the potential to impact federally listed threatened or endangered species during construction or operation. Transmission lines connecting renewable energy facilities to the grid can cause habitat loss and fragmentation, and can impact listed species as well.

Most renewable energy is generated in the central western California, great central valley and southwestern California bioregions, except for hydropower facilities, which are predominately in the Sierra Nevada, Cascade Ranges, and southwestern California Bioregions (based on the Jepson Manual [Hickman 1993]). Future renewable expansion, based on Energy Commission Renewable energy auction results, is expected to include:

- Wind development in Alameda, Kern, Riverside, Solano, and Los Angeles Counties
- Landfill gas (a waste-to-energy technology) development in San Bernardino, Santa Cruz, Contra Costa, San Mateo, Riverside, and Alameda Counties
- Geothermal development in Imperial and Siskiyou Counties
- Small hydropower facilities development within El Dorado, Amador, Alpine, Alameda, San Diego, and Riverside Counties

These facilities are predominately in the Southwestern California, central western California, and Mojave Desert bioregions.

[6] A non-point source is any source of pollutants which does not meet the criteria of a point source per 502(14) of the Clean Water Act. Non-point sources are typically runoff, rainfall, atmospheric deposition, drainage or seepage.

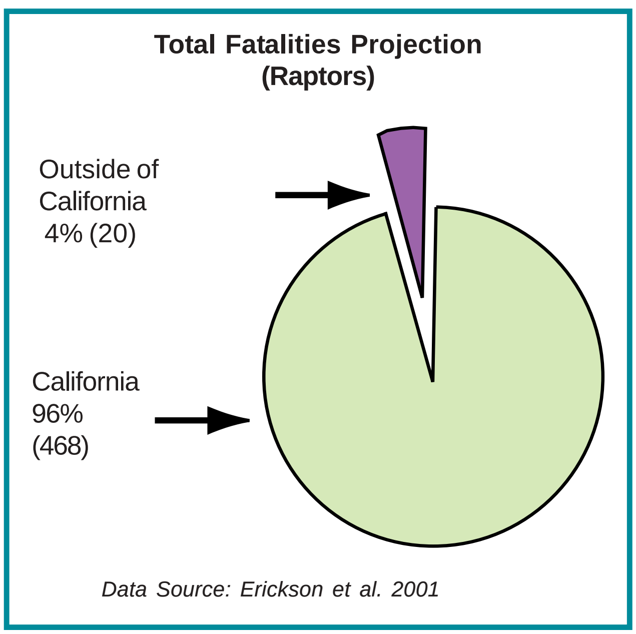
A proliferation of geothermal, small hydropower, wind, and solar thermal power generating facilities will require additions to the electrical transmission system and associated right-of-ways to deliver power where the electricity is needed. Building-integrated renewable technologies, such as solar photovoltaic, may not create a need for transmission line development (see Appendix III-2, Data Table 9).

- **Finding:** As utilities make plans to meet the state policy to have 20 percent renewables in all energy portfolios, they should consider impacts to biological resources, such as the effect of wind generation on avian populations. Impacts from upgrading the transmission systems to reach renewable areas should also be evaluated.

Wind

California is one of the leaders in wind energy generation in the United States. In descending order of megawatt capacity, the five major wind resource areas in California are Tehachapi Pass, San Gorgonio Pass, Altamont Pass, Montezuma Hills, and Pacheco Pass. California's wind resource

**Figure III-17:
Estimated Total Raptor Fatalities
from U.S. Wind Turgines, 2001**



areas cover approximately 106,403 acres (Appendix III-2, Data Table 10). Not all of the acres designated as part of the wind resource areas are impacted by wind turbines because spacing between turbines can be one to three times the rotor diameter (about 50 to 600 feet), and spacing between turbine rows is typically eight to twelve rotor diameters (about 400 to 2,350 feet). In addition, many of the wind resource areas are not fully built out. Acres impacted by wind turbine pads and roads are estimated to be between 5 percent and 34 percent of the available wind resource areas (Appendix III-2, Data Table 10). Wind turbine pads accounted for a very small percentage of the disturbance (cumulatively about 45 acres). Staff expects future habitat loss due to wind energy development to stay constant even with new wind development or expansion because the access roads are already developed.

The largest single issue concerning wind turbines continues to be bird strikes with turbine blades. Research has found that the majority of wind turbine-caused bird fatalities appear to occur in California, primarily at the Altamont Pass wind resource area (Erickson *et al*. 2001; **Figure III-17**). A number of factors contribute to the higher number of fatalities in California (Sterner 2002). As an early leader in wind energy production, many of California's wind resource areas were built before there was an understanding of bird fatality risk.[6] A handbook to address wind generating siting and permitting issues has helped reduce potential fatalities by reducing the placement of wind developments in areas with high-density raptor populations or areas with topographic diversity (Anderson et al. 1999). However, at existing wind farms with high bird collision incidence, no mitigation measures are known to reduce bird fatalities. Additionally, estimates of bird use at a wind farm site currently being developed at Montezuma Hills wind resource area suggest that this area could exceed the bird fatalities at Altamont Pass wind resource area.

The current trend in wind energy development is to replace existing smaller and less efficient turbines with much larger, more efficient designs. Because these repowered wind farms will result in fewer turbines, reduced rotational speed and an increase in tip distance from the ground, repowering may reduce bird collisions with turbine blades (Hunt 2002, Sterner 2002). In 1996 the total rotor swept area[7] was about 3,900,000 square meters. By 2002 it had decreased to 3,650,000 (Appendix III-2, Data Table 10). However, as more of the repower facilities come back on-line, the total amount of rotor swept area, a factor considered highly contributory to bird fatality risk, is estimated to remain about the same or increase with the correspondingly larger turbine blades (Sterner 2002). Research is needed to better understand the relative importance of various factors such as topography, threshold level of bird use, and turbine design features that contribute most significantly to bird collision risk (Indicator BIO7). Most importantly, with the current trend to repower sites with much larger turbines, research aimed at understanding the collision risk associated with these new designs is paramount to reducing both the current and potential fatal risk of bird collisions with turbine blades.

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[7] For example, the Altamont Pass wind resource area was built in an area of high raptor use and diverse topographic landscape, both significant factors that contribute to collision risk. Conservative estimates show that at least 1,000 birds, more than 50 percent of these being raptors, are killed annually at the Altamont Pass wind resource area (Thelander and Rugge 2000).

[8] The amount of surface area covered by a single sweep of the rotor blade.

- ***Indicator BIO7:*** Track how current wind turbine configurations and repowering efforts have impacted biological communities. Track how wind turbines impact biological communities in new wind farm areas or in expansion areas.

- **Finding*:*** The largest single issue concerning wind turbines continues to be bird strikes and the ability to reduce strikes with proper planning. Ongoing repower efforts can reduce or increase the amount of statewide rotor swept area, which is a factor considered highly contributory to bird fatality risk. Current repower efforts have decreased rotor swept area statewide.

Geothermal

Electricity generated from geothermal energy in Imperial, Inyo, Lassen, Mono, Mendocino, Lake and Sonoma Counties (see Division of Oil, Gas, and Geothermal Resources website for maps). These areas were predominately developed in the 1970s. In 2002, the state's 46 operating geothermal power plants produced about 2,561 MW, of which 19 facilities (1,977 MW) were sited under the Energy Commission's jurisdiction. Only two geothermal projects have been developed since 1996 and both were in Salton Sea Known Geothermal Resource Area (KGRA). One was an expansion of an existing plant, and one was a new 49 MW power plant on a 20-acre agricultural parcel, but neither was under Energy Commission jurisdiction. A 180 MW unit at the Salton Sea KGRA is currently under review at the Energy Commission.

New geothermal energy are in development in Siskiyou County within the Glass Mountain KGRA. The Energy Commission has helped fund exploratory wells in this area and the Bureau of Land Management has approved two projects; Fourmile Hill Project was approved in May 2000 and Telephone Flat was approved in November 2002 after extensive analysis of potential impacts, especially to tribal use of Medicine Lake. The development in Glass Mountain KGRA will increase the number of federally-listed species (*e.g.*, northern spotted owl, marbled murrelet) impacted by geothermal power because it is being established in a previously undisturbed habitat type. Continued development in Salton Sea KGRA is also expected over the next few years as technologies to handle the geothermal brine are improved. Air pollutants, avian collisions, and noise are concerns in this KGRA because the Salton Sea National Wildlife Refuge hosts a large portion of migratory birds and federally listed species.

Solar Power

In California, solar thermal power plants are concentrated in San Bernardino County. Because these projects are greater than 50 MW and thermal, they were permitted by the Energy Commission in the late 1980s and early 1990s, but no new applications have been submitted since deregulation in 1996. Solar thermal has only been built in the Mojave Desert where one federally-listed species, the desert tortoise, was impacted (Appendix III-2, Data Table 6).

The Energy Commission does not have permitting jurisdiction over solar photovoltaic installations, but has supported rooftop facilities through grant and buyback programs. To date, development of free-standing large arrays (> 1 MW) of solar photovoltaic cells has only occurred at Rancho Seco (Sacramento County) and in Davis (Yolo County). These installations did not have impacts on federally-listed species, but maintenance and expansions could impact vernal pool species. Several major municipal utilities (San Diego, San Francisco) have decided to increase the amount of solar photovoltaic in their generation portfolio and are installing systems on rooftops of large facilities or on individual family homes. Biological resources impacts from urban rooftop installations are highly unlikely, but new free-standing arrays on undisturbed land could result in habitat losses and possible impacts to sensitive species.

Waste to Energy

Waste-to-energy facilities burn discarded fuels or residues directly (such as wood or straw) or methane gas produced from decomposing waste. These two fuel types are typically found in urban areas, but wood fuel can also come from forest thinning or other forest management. The Energy Commission does not permit these facilities, because all are less than 50 MW.

The biomass-to-energy industry categorizes biomass fuels as wood processing, in-forest, agricultural, and urban wood residues (IWMB 2001). The number of biomass plants in operation fluctuate due, in part, to fuel supply, fuel availability, and the price of electricity. In 1996, 28 out of 100 waste-to-energy facilities used biomass fuels, representing 62 percent of the total electrical generation from these facilities. The number of online biomass plants increased during the energy crisis of 2000 and 2001 (Morris 2002). As of February 2003, there were 35 biomass facilities in operation, most located in urban and agricultural areas. When located in forested habitats, biomass power plants may have impacted several federally listed species during construction (Appendix III-2, Data Table 6), and the roads to supply the fuel to the facility may have caused habitat fragmentation (see Appendix III-3, Note 8).

Under the National Fire Plan (NFP 2003), the U.S. Department of the Interior and U.S. Department of Agriculture have scheduled 143,673 acres of California forest land for hazardous fuels treatment to reduce the risk of fire. Although more information is needed on the numbers of acres to be treated by mechanical thinning versus controlled burns for fiscal year 2003 and beyond, it is likely that forest residue generated by National Fire Plan activities could provide sources of fuel for biomass energy plants at a reasonable cost. Additional research is needed to better document the biological resource impacts of forest thinning that could be used in biomass facilities.

- ***Indicator BIO8:*** Track availability of forest-based fuels by region and research whether thinning activities in those regions could promote forest health or impact local biological resources.

Methane, another waste-to-energy fuel, is a potent greenhouse gas. The burning of methane in a electric generating facility produces less potent carbon dioxide, and is seen as an air quality benefit. Microturbines and internal combustion engines burn methane gas collected from large containers and ponds of solid waste (sewage or dairy waste) or from wells drilled into landfills (landfills create methane gas during decomposition that must be vented). Microturbine technology has developed to a level where 1.5 MW of power can be created in the space of a 20-car parking lot (Sacramento Public Works 2003). Siting of these facilities in already developed areas reduces the potential for impacts to biological resources.

Small Hydropower

California's Renewable Portfolio Standard promotes the use of small hydropower as long as such facilities are 30 MW or less and do not entail new water appropriations or diversions. However, impacts associated with small hydropower facilities are often the same as those associated with large hydropower facilities (*e.g.* habitat loss and fragmentation through inundation, dewatering of stream reaches, dam construction, and degradation of habitat due to changes to water temperature, sedimentation and scouring). Opportunities to increase renewable hydropower production without additional environmental damage include:

1. the addition of small turbines to canals, water supply facilities and pipelines,
2. incremental hydro, and
3. the addition of turbines to existing dams lacking hydropower generation.

Incremental hydro is the addition of generation at a hydropower facility that is already generating power. The incremental power may come from water not already in use for generation purposes (*e.g.,* water in a fish passage system).

Since 1996, the only addition of turbines to a non-hydropower facility was at the Diamond Valley Lake (formerly Eastside Reservoir), completed in May 2001. Four existing pumps were converted to hydroelectric turbines and the facility now generates 13 MW of electricity, and eight additional pumps could be converted for a total of 40 MW. Although any proposal for retrofitting storage facilities would need to be scrutinized for potential environmental impacts, in some cases retrofit of existing facilities for hydropower generation could likely have less impact to biological resources than construction and operation of new small hydropower facilities. Staff will track and assess the hydropower changes using Indicator BIO9.

- *Indicator BIO9*: Inventory the biological effects of hydropower facilities and identify opportunities for additional and increased hydropower generation without additional environmental impacts.

Natural Gas and Transmission Line Systems Impacts on Biological Resources

In California, there are approximately 31,720 miles of transmission lines, 200,000 miles of distribution lines, and 11,600 miles of major natural gas pipelines. In addition to the habitat loss, fragmentation (see Appendix III-3, Note 11), and degradation, these linear features can cause bird fatality from collision and electrocution. Any new transmission line projects have the possibility of degrading habitat for state or federally listed species or critical habitat. Two proposed transmission line projects are within approved multi-species protection plan areas, and several projects could cross reserves set aside by these planning efforts (*e.g.*, the Jefferson-Martin 230kV; Appendix III-2, Data Table 11). Nine of twelve new transmission lines closely parallel an existing right-of-way, which limits the fragmentation of habitat.

Most transmission line and natural gas right-of-ways are located in urban and agricultural areas, but many cross the Mojave Desert and a few major corridors traverse forested regions of northern and eastern California (Appendix III-2, Data Table 7). Desert communities may still be impacted during operation because of their slow recovery times (see Appendix III-3, Note 2). Four of the five new natural gas pipelines built since 1996 are located in Kern County or further south, so most are impacting some portion of the Mojave Desert (**Table III-6**). However, all of the new natural gas pipelines also have significant portions in urban areas. Two of the five transmission line facilities built since 1996 were constructed in the San Francisco Bay Area and three of the five were associated with agricultural and urban areas. However, desert environments continue to be impacted by the new transmission lines (*e.g.*, the 200+ mile Mead-Adelanto project, **Table III-6**).

- **Finding:** California's transmission line and natural gas pipeline right-of-ways are mainly in agricultural and urban habitats, but many cross the Mojave Desert where vegetation is slow to recover.

Environmental Impacts from Electric Transmission Lines

Periodic vegetation management in transmission line right-of-ways often results in disruption of the natural community and the structure and function of the wildlife habitats. Transmission line right-of-way maintenance can also introduce and encourage invasive non-native plant and animal species, which may displace native species, disrupt nutrient and natural fire cycles, and change plant succession patterns. Adjacent habitat can also be inadvertently affected by right-of-way maintenance (*e.g.,* overspray of herbicides, noise from crews). More agencies and institutions are also becoming concerned with how to approach right-of-way management (*e.g.,* Goodrich-Mahoney *et al.* 2002).

Transmission line-related wildfires can occur when storms knock down transmission line towers and/or conductors and when trees and other tall vegetation come in contact with or in close proximity to the conductors. If a fire occurs in a native plant community that is not a "fire-related" plant community (*i.e*. not dependent upon periodic fire during its maturation process), then the post-fire plant community is likely to favor non-native, weedy plant species. Wildlife species composition changes following a fire are also likely in certain habitat types. Wildlife species changes can favor the establishment of disturbance-related species. The total number of acres burned (from all causes) is highly variable from year to year; however there has been a substantial decrease in acres burned related to transmission lines since 1996 (**Table III-7**). The current trend is that the frequency of wildfires due to transmission lines has been diminishing.

Some of California's rarest natural communities, including a variety of Central Valley vernal pool types and coastal natural communities, are within 1.2 miles (2 kilometers) of a transmission line or natural gas pipeline (Appendix III-2, Data Table 7). Many state and federally protected wildlife, plant and invertebrate species occur in these areas. Periodic maintenance activities, primarily related to existing transmission lines, could harm some of the remaining acreage of these sensitive habitat types and the protected species associated with them when emergencies, such as fire, occur during sensitive times (*e.g.,* nesting season).

Project Name (Location)	**Project Length**	**Natural Communities* Within A Corridor In Order Of Dominance**
Natural Gas Pipeline		
Socal Gas Line 6900 (Southeastern California)	10 miles	Urban
North Baja Pipeline (Southern California)	80 miles	Desert scrub, desert wash woodland, croplands, Southern mixed chaparral, desert succulent scrub, coastal sage scrub, annual grassland, urban
Kern River High Desert Lateral (Eastern Kern County)	33 miles	Desert Scrub, alkali desert scrub, urban
Socal Gas Kramer Junction (Eastern Kern County)	32 miles	Desert scrub, alkali desert scrub
PG&E Redwood Path (Northeastern California)	14 miles	Subalpine conifer, ponderosa pine, foothill pine-oak woodland, eastside pine, Douglas fir forest, blue oak woodland
Total	**169 Miles**	Losses in desert scrub, desert wash woodland, croplands, and urban dominant
Electrical Transmission Lines		
Westley-Tracy (San Joaquin County)	30 miles	Annual grasslands, irrigated row and field crops
Mead-Adelanto (Mojave Desert)	202 miles	Desert scrub, cropland, alkali desert scrub, urban, riverrine, desert riparian
Alturas Intertie (Great Basin)	163 miles	Sagebrush, pasture, juniper, lacustrine, low sage, perennial grassland, dryland grain crops, alkali desert scrub, freshwater emergent, urban, barren
Northeast San Jose Transmission Reinforcement (City of San Jose)	16 miles	Urban
Tri-Valley Long Term Transmission (E. Bay area Coast Range)	2.5 miles overhead and 11.8 miles underground	Annual grasslands, cropland
Total	**425.3 Miles**	Impacts in desert scrub, sagebrush, pasture, and urban dominant

* Based on Holland 1986

Table III-6: Natural Communities within 1.2 Mile (2 Km) Corridors around New Major Natural Gas Pipelines and Electrical Transmission Lines constructed in California Since 1996

Avian fatalities from collision and electrocution with power lines were first identified in the late 1800s. Birds with long wing spans, such as raptors, are the most susceptible to electrocution. Collisions are most frequently documented with high voltage (greater than 69 kV) transmission lines; however, recent evidence suggests that collision with lower voltage distribution lines is a problem (Hunting 2002). Waterfowl and water birds appear to be most susceptible to power line collisions in wetland areas, while raptors and passerines (song birds) appear to be more susceptible in upland habitats. Due to poor reporting requirements, and the lack of monitoring and standardized techniques, the extent of avian fatalities (most notably migratory birds) in California and the U.S. is unknown. The most comprehensive collision study in California, conducted by PG&E, estimated 50 to 500 annual fatal strikes per kilometer per year at Mare Island, depending on desirability of the surrounding habitat type and its bird use (Hartman *et al.* 1992). The 7.9 mile transmission line on Mare Island was eventually fitted with bird flight diverters to decrease avian losses, but no follow up study has been done for their effectiveness. No comprehensive state-wide study has been conducted on avian electrocution.

Year	Number of transmission line-related fires*	Acres burned*
1991	249	6,712
1992	279	10,982
1993	292	53,373
1994	271	2,189
1995	307	2,475
1996	284	5,721
1997	226	4,559
1998	155	3,354
1999	179	3,954
2000	173	1,844
2001	182	9,811
2002	181	730

* The count and number of acres from powerline fires is for State Responsibility Areas only, about 31 million out of the state's 99 million acres.
Source: California Department of Forestry and Fire Protection, annual records

Table III-7: California Fires from Transmission Lines Over Time

Progress has been made in the last decade to understand causes of avian collision and electrocution risk, but solutions developed to date are still largely unproven or have been proven ineffective. Research is needed to gain a more complete understanding of the magnitude of the problem and to develop and test more effective area- and species-specific mitigation and remediation measures. Staff proposes to track and review and support research into avian collision and electrocution with power lines (Indicator BIO10). Construction and maintenance of power lines in refuges and preserves would be particularly devastating to the protection of biological resources, so projects should reduce the likelihood of new overhead transmission lines in these areas.

Impacts of Transmission Lines on Federal Wildlife Refuges

Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) is a 23,000 acre refuge located at the southern end of San Francisco Bay. At least two transmission lines cross the Refuge. The Refuge recently analyzed the addition of transmission lines for the Northeast San Jose Reinforcement transmission line project (CPUC Application 99-09-029, Decision D.01-05-059). Originally, the project was proposed to be located next to an existing transmission line located on the Refuge. However, the USFWS argued that the proposed transmission line was not compatible with the Refuge, so the final alignment was moved off of the Refuge. Staff anticipates that the trend at refuges will be to determine that transmission lines are not compatible with refuges, and to try to have existing transmission lines removed when tower or conductor upgrades are needed, to require new lines adjacent to the refuge be installed underground, and to require that bird flight diverters be installed on new ground wires and fiber optic lines because there are documented waterfowl and wading bird collisions with these facilities. The transmission line towers may also provide perch opportunities for species such as ravens and crows that prey upon listed species. (See also Appendix III-3, Note 12.)

- ***Indicator BIO10:*** Track and support research on the impact of distribution and transmission lines on surrounding species and habitats in order to keep up to date on new mitigation measures and technology.

- **Finding*:*** New transmission line, natural gas pipeline, or water supply pipeline right-of-ways for new power plants under Commission jurisdiction should, where possible, avoid federal or state wildlife refuges or preserves, public or private habitat mitigation banks, or other similar protected areas (unless they are within an approved utility corridor) because that perpetuates impacts to species which need protection from further habitat loss.

Imported Power Impacts on Biological Resources

Fifteen to thirty percent of the statewide energy demand is served from sources outside of state borders. The impact of these power plants on out-of-state natural resources can range from air and water pollution (from plants in Mexico and the southwest) to destruction of fish populations (hydropower dams in the northwest). In-state natural resources may also be impacted by the transmission lines required to bring the energy to the user. A brief overview of some of the impacts associated with out-of-state electricity generation is presented below.

Two natural gas export pipelines have been built between California and Mexico since 1996; the Rosarito Pipeline (operational in April 2000) and the North Baja Pipeline (operational September 2002). The U.S. agencies permitting these projects mitigated all in-state impacts. The Mexican government was responsible for reviewing the biological impacts from the Mexico portion of the pipeline. The Department of Energy, Office of Fossil Energy, has issued two Presidential Permits to expand the transmission line capacity across the border with Mexico (Orders Nos. PP-234 and PP-235, FERC). The Department of Energy, in conjunction with the Bureau of Land Management prepared an environmental analysis of two 230 kV electrical transmission circuits (USDOE and BLM 20001) and in December 2001, they issued a Finding of No Significant Impact. These permits were subsequently litigated for failing to consider transboundary impacts as associated actions.

The majority of recent impacts are related to temporary disturbance of right-of-ways to connect infrastructure of the two countries, but future impacts could be larger and permanent. So far, power plant and associated infrastructure development in Mexico has had a small level of impact on biological resources within California, but U.S. agencies are unable to determine impacts on the other side of the border. Staff should stay informed concerning this matter related to potential cross-border issues. (Indicator BIO11).

- ***Indicator BIO11:*** Track number of international, interstate, and interagency agreements that review impacts from transmission lines and natural gas pipelines in a transboundary format.

Several power plants have been constructed in Mexico that will export power exclusively or in large part to the United States; for instance, the Intergen and Sempra power plants in Mexicali, Mexico. These power plants use wastewater from Mexico's Zaragoza Wastewater Treatment Plant (ZWTP) for their cooling cycle, and the Colorado River Basin Regional Water Quality Control Board estimates another five power plants will use the ZWTP in the future. After use by the power plants, the wastewater is discharged to drainage channels that enter the New River, which flows into California. After several cycles of cooling, the wastewater will have concentrated levels of pollutants and salts. The Salton Sea and the New River are plagued with salinity and other pollution problems, but the increase in pollutants produced by these two power plants is de minimus to the Salton Sea. The annual inflow to Salton Sea is approximately 1,363,000 acre feet annually, while the entire ZWTP supply is approximately 25,000 acre feet annually (2 percent of the total). The Sempra plant would discharge approximately 850 acre feet annually (0.06 percent of total). The Bureau of Land Management estimated the salinity of the Salton Sea could increase only 0.142 percent from operation of the Intergen and Sempra power plants (USDOE and BLM 2001). In addition, there are major efforts under way to solve the pollution problems in the New River through the funding of an additional wastewater treatment plant under the Mexicali II Project.

California receives 7,000 to 29,000 MW of power per year from the Pacific Northwest; amounts vary based on drought or high rainfall years and market conditions. Based on research for hydro-power relicensing being done by Oak Ridge National Laboratory (ONRL 1993), the biggest issue for Northwest hydropower has been the blockage of upstream and downstream movement of fish. Salmon must be able to migrate upstream from the ocean to reproduce in fresh water. There has been a reduction of the Pacific Northwest salmon population from about 16 million to 300,000 wild fish each year. Fish ladders and shuttling fish around the dams in boats or trucks have been used in an attempt to mitigate this impact. Despite recent extraordinary efforts, they have not yet achieved any clear indication that recovery of these species is possible.

Other problems with northwest hydropower dams are supersaturation, inadequate minimum flow, and death by turbine blades. Supersaturation was a big problem on the Columbia River. Supersaturation is the spilling of water over spillways which forces atmospheric gases into solution, making the basin water supersaturated. The gas bubbles, which are absorbed into fish tissue, may cause damage and ultimately kill the fish. Dams are now being designed with "flips" in their spillways to reduce this impact. The flips slow the force of the water and fewer gas bubbles are formed. The need for minimum flows to protect aquatic habitat is the most common problem that must be addressed in licensing and relicensing hydropower dams in the Pacific Northwest. Just like California's dams, low flows can strand fish in shallow water or dry out the habitat while high flows can flush out egg masses from their protected locations. Turbine and intake screen designs are also being considered in licensing and relicensing hydropower dams in the Pacific Northwestern. Certain turbine designs have blades that are properly spaced and turn at the right revolution so as not to present a threat to fish. Intake screens can be designed to prevent fish from being drawn into the turbine or being pinned to the screen. What is needed is an effective standard design for turbines that is proven to protect fish and that would be considered for use by all developers of hydropower.

Coal-fired out-of-state power plants provide energy to California, but can create air quality problems in other states. While there are many types of air quality impacts, staff has initially reviewed mercury emissions. U.S. utilities are estimated to account for roughly 1 percent of the total global mercury emissions (both natural and anthropogenic), or about 50 to 55 tons per year (USEPA 1998 and 1999). Mercury is a known neurotoxin to humans, other mammals, and birds. Mercury can concentrate up the food chain and cause adverse impacts to fish-eating wildlife species such as loons, mink and otter, but is not currently accumulating to lethal levels (Evers *et al.* 2002, Kaplan and Tischler 2000). In December 2000, the USEPA decided to regulate the mercury emissions from coal- and oil-fired power plants. The estimated mercury emissions from the out-of-state power plants that contribute to California's net generation range from 0.007 to 0.4 tons per year (Appendix III-2, Data Table 12). For comparison, in states like Ohio and Texas, levels of mercury emissions are near 3 to 4.5 tons per year, while in California the total is 0.0030 tons. Most of the mercury emissions reside in terrestrial soils (about 95 percent; USEPA 1998), where it is trapped until released into water by leaching (when attached to a water soluble substrate) or becomes wind blown. Overall, the release rates of mercury from soils into fresh and coastal waters are very slow and mercury uptake into ecosystems is minimal.

The City of Los Angeles Department of Water and Power (LADWP), Southern California Edison, Imperial Irrigation District and other California municipal utilities partially own coal-fired power plants outside of California. The operation of these coal-fired plants is approximately equal to one in-state nuclear facility, or a modern 1,100-megawatt (MW) natural-gas-fired combined-cycle generating facility (such as East Altamont [01-AFC-4] or Morro Bay [00-AFC-12]) which have little or no mercury emissions.

Summary and Conclusions

The impact of electric infrastructure on biological resources are related to habitat loss and associated fragmentation, degradation of terrestrial and aquatic habitat, direct and indirect species fatalities, air and water pollution, and noise disturbance. Staff has consistently found significant impacts could occur during power plant construction and operation, and while some impacts are short-term and easily avoided or mitigated, others are on-going and cumulative. Most cumulative impacts are the result of power plant operation, which is typically for 30 or more years. The impact to biological resources from peakers during the 2000 and 2001 energy crisis was *de minimus*.

Construction of transmission lines and natural gas pipeline right-of-ways can have ongoing impacts from maintenance. Proposed expansion of these facilities will be necessary to supply our growing population and to connect renewable facilities to the grid. In-state infrastructure is also needed when importing electricity from outside of California.

Since deregulation in 1996, several trends have emerged:

- The majority of new power plants are natural gas-fired power plants, sited in the interior of California, bringing a new set of impacts such as nitrogen deposition.
- Most renewable-energy facilities have been built on previously disturbed areas, limiting adverse impacts on biological resources. For example, most of the habitat disturbance from wind power is from roads, and repower efforts have not increased road density.
- Turbines at wind farms are being replaced and rotor swept area, which is a factor considered highly contributory to bird fatality risk, has decreased because many turbines were taken off line during construction. As the new turbines come on-line, the amount of rotor swept area may increase, which increases the risk of bird fatalities.
- The Energy Commission has received five applications to repower or modernize existing power plants that use once-through cooling. Two of these projects have been approved and are now at least partially on-line. The other three are still under consideration by the Energy Commission.
- No new hydropower facilities have been built, though turbines were added to a single existing dam that did not previously produce electricity. Hydropower facilities under relicensing have changed their operation procedures which benefit biological resources and some dams have been proposed for removal.
- Large-scale habitat conservation plans, which allow private development to “take” listed species, have given project proponents a new way to offset impacts to federally- and state-listed species.

All of these trends will likely continue for the next few years.

Environmental Performance Report
Chapter 3
Environmental Performance: Water Resources

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Water Resources

Clean fresh water is an increasingly critical resource in California. Energy facilities are among the state's many water users and have the potential to affect fresh water supply and water quality. This section provides an overview of water use and wastewater discharges associated with the generation of electricity.

Summary of findings

Water Supply

- Competition for the state's limited fresh water supply is increasing and in some years contractual obligations to supply water cannot be met.
- Water use for power plant cooling can cause significant impacts to local water supplies, but tends to be a small use at the aggregate state level.
- Since 1996, an increasing number of new power plants have been sited in areas with limited fresh water supplies. More than 5,700 MW of new power has been constructed or is being licensed within southern California. As a result, use of fresh water for power plant cooling is increasing.
- Degraded surface and groundwater can be re-used for power plant cooling. When sufficient quantities are available, reclaimed water is a commercially viable cooling medium**.** Of the 4,516 MW of new capacity brought on-line since 1996, more than 1,400 MW (31%) is cooled using recycled water.
- Alternative cooling options such as dry cooling are available and commercially viable that can reduce or eliminate the need for fresh water. Two projects using dry or air cooling became operational between 1996 and 2002. A third project using dry cooling in San Diego County has been permitted by the Energy Commission.
- Water use data for power generation is not readily available and significantly hampers the Energy Commission's ability to report on water use trends.

Water Quality

- Water quality impacts to surface water bodies, groundwater and land from waste water discharge are being increasingly controlled through use of technologies such as zero liquid discharge systems. Of the 4,516 MW of new capacity brought online between 1996 and 2002, 12 percent use zero liquid discharge. More than 35 percent of the projects under licensing review or under construction will use this technology.
- No power plants using once-through cooling have been proposed at new California coastal sites in the last two decades. Continued use of once-through cooling at existing and repowered power plants perpetuates impacts to aquatic resources in coastal zone, bays and estuaries.

- Hydroelectric facilities can cause permanent alterations to stream flows, raise water temperatures, alter dissolved oxygen levels, and cause changes to the aquatic environment.

Key Water Permitting Issues for New Power Plants

- Reduce the use of fresh surface water and groundwater for power plant cooling. Power plants can be cooled with degraded water from reclaimed and recycled sources, and by alternative technologies such as dry cooling.
- Reduce wastewater discharges to land, groundwater or surface water bodies through use of zero liquid discharge systems.
- Assess and mitigate long-term impacts to aquatic ecosystems in marine and estuarine environments resulting from the use of once-through cooling by power plants in the coastal zones.

How Power Plants Use Water and Affect Water Quality

Power plants operating in California use and affect water in various ways depending on the type of generation and cooling technology used. Water demand and associated discharges are a function of the type, size and operation of the facility. For purposes of discussing water resource issues, power plants are generally characterized as thermal and non-thermal plants.

Thermal power plants convert natural gas, geothermal fluid, coal, fuel oil, solar heat, nuclear or biomass energy to electric energy and waste heat. Water is used to create steam, remove waste heat, and condense steam. Steam-cycle plants use steam to drive a turbine and electric generator. The major water use is for creating and condensing steam. Combined-cycle thermal power plants use two power cycles to produce electricity: a combustion turbine turns a generator in the first cycle, and the hot exhaust is used to produce steam to drive a steam turbine in the second cycle. The major water use is for steam condensation. Simple-cycle facilities use a combustion turbine only, and use comparatively little water.

Geothermal electricity generation taps heated water-bearing or brine reservoirs below the earth's surface to drive a steam turbine. Solar-thermal technologies use the sun's heat to create steam to drive an electric generator. Parabolic trough systems, like those operating in southern California, use reflectors to concentrate sunlight to heat oil that in turn creates steam to drive a steam turbine.

Water quantity and quality can be impacted by:
- effluent and thermal discharge from power plants;
- lowered water tables from over-pumping groundwater sources for power plant use;
- spills from petroleum transport tankers or pipelines;
- dams and impoundments for hydropower, which alter natural river flows and affect
- ecological systems;
- construction and maintenance of transmission lines and natural gas pipelines that traverse water bodies;
- atmospheric deposition of nutrients, toxins, and salts from power plant emissions; and
- storm-water runoff (petroleum products and heavy metals) from power plants sites.

As with combustion thermal facilities, water used in geothermal and solar thermal plants is to generate or augment steam production, for cooling and other internal processes.

Cooling Technologies

Thermal power plants use different types of technologies for cooling. The two conventional methods are once-through cooling and recirculating cooling using wet cooling towers. Once-through cooling systems do not evaporate, or consume, water, while wet cooling tower systems evaporate, or consume, water during the cooling process. Emerging cooling methods can include dry or hybrid systems, which consume little water compared to wet cooling towers.

A once-through cooling process withdraws water from the ocean, an estuary, lake, or river and passes it through condenser tubes to condense the steam, and returns heated water to the source at temperatures typically 30 degrees F above ambient conditions. An average 500 MW natural gas-fired power plant uses up to 40,000 gallons per MWh. California's two operating nuclear facilities, San Onofre and Diablo Canyon, use once-through cooling systems. At about 2,150 MW capacity each, these are two of the state's largest power plants. Both nuclear stations use and discharge the highest volumes of seawater for the California coastal plants, ranging from 1,218 to 2,760 million gallons per day.

Wet cooling tower systems circulate cooling water through the condenser to the cooling towers, condensing steam and rejecting heat to the air through evaporative cooling in the cooling tower. Some wet cooling towers are needed to cool equipment and lubricating oils. Blowdown is the bleeding off of a small percentage of the total circulating water flow to remove impurities that are concentrated in the water through the evaporative cooling process in the tower. Most of the water required for these systems is consumed, or lost to the atmosphere as vapor and drift, or disposed of as brines.

Wastewater Discharges

Cooling tower blowdown is classified as an industrial wastewater discharge, and if not properly treated on-site requires either a National Pollutant Discharge Elimination System Permit (NPDES) to discharge liquid wastes off-site to receiving waters, a Waste Discharge Requirements permit (WDRs) to discharge to evaporation ponds, or an Industrial Wastewater Discharge permit if liquid waste is discharged to publicly owned treatment works (wastewater treatment plant).

Considering the loss of water from evaporation, drift and blowdown, total make up water requirements for a 500 MW combustion turbine combined cycle power plant using wet cooling towers are about 4,000 acre-feet per year, or about 250 gallons per MWh. This water can be derived from surface water, groundwater, or recycled water.

Two types of dry cooling systems are available that do not use water: direct dry cooling and the lesser used indirect dry cooling. In a direct dry cooling system, fans blow air over a radiator system to condense steam and remove heat. Hybrid cooling combines wet cooling tower and air-cooled systems. Two primary hybrid designs achieve both water conservation and plume abate-

Cooling Process	Consumptive or Non-Consumptive	Gallons per MWh	Acre-feet per year
Once-Through	Non-Consumptive	40,000	250,000
Wet Cooling Towers	Consumptive	250	4,000
Dry Cooling	Consumptive	50	230

Table III-8:
Comparison of Typical Water Use Levels for Cooling Technologies for a 500 MW Combined Cycle Combustion Turbine Power Plant

Consumptive Water Use makes water unavailable for recapture and reuse as a result of direct surface evaporation. Evaporation of cooling water to dissipate heat in cooling towers is an example of consumptive water use.

Non-consumptive Water Use does not deplete water supplies, but returns the used water to its source for reuse. Once through cooling is an example of non-consumptive use since no water is lost to the system.

ment. Hybrid water conservation designs reduce water use by as much as half, and hybrid plume abatement designs reduce the visible water vapor plume from the cooling system and result in about five percent water conservation.

Cooling Water Sources

Power plants use water from a variety of sources, including surface water, groundwater and bay or ocean water, and range in quality from potable to degraded or brackish. With the development of municipal recycled water programs, power plant developers have increasing opportunities to use reclaimed or recycled water to meet cooling demands. Using recycled water for power plant cooling conserves higher quality fresh water for other uses, and in certain circumstances, can replace the large quantities of ocean water used in once-through cooling processes.

The potential for new power plants to impact to local water supplies is increasing as competition for local water supplies intensifies. A power plant's impact on water supplies may vary widely depending on the source of the water and how the water is obtained (direct diversion or extraction, municipal supply, or imported through a water project). The most significant effects of fresh water use by power plants are on the current and future users of local fresh water supplies and aquatic resources. Once-through cooling using bay or ocean water affects marine and aquatic ecosystems (See the Biology Section for a discussion of these effects).

Wastewater Streams and Their Disposal

Thermal power plants produce wastewater during numerous parts of the electric generation cycle and from stormwater runoff at the plant site. Water entering a power plant is typically split into several streams. For example, for power plants using steam for primary or secondary generation, the water needs to be purified prior to its use in the steam cycle. This purification process produces a concentrated byproduct stream. Another waste stream is produced when cooling water is recirculated over the condensers to return steam to its liquid form. In a cooling tower system, as the water flows over the condensers, the majority of it is lost to evaporation. This evaporation concentrates the impurities. Blowdown is the bleeding off of a small percentage of total cooling water flow, which requires new water to be added to the system and maintain the water quality balance. In a cooling tower system, waters are typically recirculated three to five times, but can be recirculated as many as twenty times. Each time water is circulated through the system it gains increasing concentrations of salts, minerals, and chemical additives, which must be disposed of as a waste stream.

Wastewater streams from thermal power plants may degrade surface and groundwater supplies, which may adversely affect drinking water supplies and other beneficial uses, including those related to biological resources. Disposal methods include discharge of the effluent to land (evaporation ponds), rivers or other surface water bodies, local sewer systems or by injection underground. The regulations for appropriate disposal of wastewater streams are enforced by local municipalities and regional water quality control boards through the issuance of waste discharge requirements and industrial waste discharger permits.

For once-through cooling facilities, chemical constituents are added to the cooling water stream to prevent biofouling and corrosion. These chemicals are then discharged to the ocean, bay or estuary. However, unlike cooling tower systems where wastes are concentrated, wastes in a once through cooling system are diluted with the large volumes of intake cooling waters. The discharge of heated waste water back to the source waters also creates environmental effects. Wastewater temperatures may be 20 degrees F or more above the receiving water temperature. Depending on location and other specifics, these thermal discharges can result in significant impacts, primarily to aquatic habitat and resources. For more discussion of these impacts, please refer to the Biological Resources section.

Construction and operation of energy facilities can also adversely affect water resources. To prepare sites for power plants and install needed infrastructure, significant earth-moving work is required. Requirements under the National Pollution Discharge Elimination System (NPDES) program are intended to protect stormwater from being contaminated with sediments or chemicals during construction.

Cogeneration Facilities

Cogeneration facilities are power plants that not only generate electricity, but also provide waste heat, typically as steam, to a host facility, such as a food processing plant, for use in the host's systems. Actual water use by these facilities may be greater than other combined-cycled power plants since additional steam may be required to meet the requirements of the host facility. For example, the annual average water use by a 158 MW cogeneration facility was estimated at 2,100 acre-feet per year (AFY), whereas an equivalent combined-cycle facility may only use 1,500 AFY.

Geothermal Energy Facilities

Geothermal electricity generation uses heated water-bearing or brine reservoirs below the earth's surface, harnessed and brought to the surface, to drive steam turbines. The heated water or steam is then cooled and either discharged to land or re-injected into the reservoir. Geothermal steam, geysers or other forms of hot springs are usually associated with current or past magmatic or volcanic activity, limiting where these resources are found and can be developed. These facilities also tend to be small in size. For example, the South Geyser project is a 55 MW plant fed by numerous wells that supply steam from the known geothermal resources area in Sonoma County for electrical generation. The steam was cooled using cooling towers similar to those employed at other inland combined cycled plants. Data on specific water demand and steam extraction rates over time for such facilities is not readily available.

1996 Baseline Conditions

Comprehensive quantitative data related to power plant water use and discharge is not readily available. Staff is developing a data base to monitor power plant related water use and wastewater discharges in order to make comprehensive comparisons of water use and discharges for facilities in California and throughout the west.

Cooling Systems in Use Prior to 1996

Prior to 1996, gas and oil burning conventional power plants, nuclear stations and hydropower electric accounted for the majority of the electricity generated in California. Thermal facilities that included a steam cycle used either once-through cooling or cooling towers to condense steam for recirculation in the steam process. Once-through cooling facilities were located along the coast and estuaries from Humbolt Bay to San Diego because they relied upon ocean, bay or estuarine waters for their cooling water source. These 21 coastal facilities ranged in size from 135 MW to 2200 MW. By 1996 the coastal units totaled more than 22,000 MWs of capacity. Maximum water diversions for these plants ranged from 76 million gallons per day to 2760 million gallons per day.

For inland plants, cooling water was obtained from groundwater and surface water sources. Inland facilities, lacking the large quantities available to coastal facilities, used conventional recirculating cooling towers. Power plants that use cooling towers use less water per megawatt than once-through cooling systems, but use that water consumptively. In addition, older facilities using less efficient technologies require more water per megawatt generated to cool their systems. For example, two steam boiler units and associated turbines that became operational in 1968 at the Moss Landing power plant have a generation capacity of 1,500 MW and require 600,000 gallons per minute for cooling. In contrast, two of the new combined-cycle units at Moss Landing that became operational in 2002 produce 1,206 MW and only require 250,000 gallons per minute for once-through cooling.

Improvements in technology from the post World War II era to the mid-1990’s resulted in gas-fired combustion turbines (both simple- and combined-cycle) replacing boiler (Rankine cycle) technology. Rankine cycle power plants typically have an efficiency rate around 33 percent, meaning for every unit of electricity generated, approximately three units of fuel are required. The less efficient the power plant, the more waste heat that must be dissipated and thus the more cooling required. In contrast, a combined-cycle facility can reach nearly 55 percent efficiency, with only a portion of the megawatts generated come from a steam cycle (approximately one third). Generally speaking, a 1000 MW Rankine cycle facility uses roughly three times the water that 1000 MW combined cycle would use.

As of 1996, wastewater discharge from power plants was commonly returned to surface water. Two facilities used large evaporation pond systems, and several re-injected water back into a saline aquifer formation, typically in association with oil fields in Kern County. Taking into account the cycles of concentration in the cooling towers and method of disposal, wastewater streams for these plants can be a fraction (one-fifth or less) of the amount of the initial water demand. Effluent from plants with evaporative cooling systems contained concentrated chemical constituents from the plant's cooling tower blowdown and water treatment system wastes, added chemicals required as part of the various plant processes and metal cleaning wastes.

Geographic Distribution of Power Facilities and Water Resources

Regional Water Supplies

California is characterized by 10 geographically-defined hydrologic regions. These hydrologic areas are listed below in decreasing order of relative "average" rainwater abundance (DWR 1998): North Coast, Sacramento River, San Joaquin River, Tulare Lake, Central Coast, South Coast, South Lahontan, North Lahontan, San Francisco, and Colorado River.

California's burgeoning population is expected to increase further to 47.5 million people by 2020, up from 34 million in 2000. The amount of water needed for urban uses is projected to increase from 8.8 million acre-feet per year currently, to 12 million AFY (an increase of approximately 36 percent) by 2020 (DWR 1998). California's average year water demand will increase from 79.5 million AFY in 1995 to 80.5 million AFY in 2020. In order to meet increases in demand resulting from population growth and increased development, the State expects to expand conservation programs and increase the efficiency of water use.

Intra-state imbalances in water supply are a result of complex geography and climate. Distribution of fresh water in the state is uneven, with over 70 percent of California's surface water occurring in the northern region. In contrast, at least 75 percent of the demand for urban and agricultural uses of water occurs south of Sacramento (DWR 1998).

Southern California as a whole has been struggling with fresh water shortages for decades. Due to low average annual rainfall, much of the water supply is imported for this heavily urbanized area. While the south coast covers 7 percent of California's area, it contains more than 50 percent of the population (DWR 1998, DOF 2001, EPA 1993). Los Angeles County's population alone accounted for nearly 30 percent of California's population (more than 9.5 million) in 2000 and contributes to enormous demands for fresh water (City of Los Angeles 2002; ENSR 2002; DOF 2000).

Future "average year" fresh water shortages are expected in every region of California except the San Francisco Bay and North Coast regions. Future water shortages will have direct and indirect adverse economic and environmental impacts, including potentially higher costs to all water users, and indirect impacts on how decisions are made in the siting, design, management, and growth of industry, including power facilities. Increasing water demand will require increased exchanges throughout the state and interstate West, accompanied by, increased water conservation and development of alternative water sources (*e.g.*, recycled water, groundwater reclamation, and desalination) and improvements and use of technologies that conserve water (DWR 1998; LADWP 2002).

In order to prevent water shortages and improve water accessibility, California has developed large and small-scale water conveyance and storage systems to supply regions of limited or constrained water supplies with adequate supplies (DWR 1998). **Figure III-18** illustrates water sources in California, areas of water consumption, and the regional transfers that are used to meet water use demand in the southern part of the state.

The availability of fresh water can be a major constraint for new projects. Some developers are dependent on imported water supplies for their projects. For example, the High Desert Power Plant located in the Mojave Desert will use State Water Project (SWP) water for plant operation. The operator will also store SWP water in a groundwater bank. When SWP supplies are not available, the project developer will use the banked groundwater. Similarly, Pastoria Energy Center located in southern San Joaquin Valley will use excess SWP water obtained through a local water district's pool. When no such water is available, the project will use banked groundwater from the Kern Water Bank or will not operate.

Most of the state's surface water supplies currently experience both average year and drought year shortages, which are expected to increase by 2020 (DWR 1998). Additional shortages are likely to result not only from population increases, but also from increased water needed for environmental purposes, particularly for the north coast rivers and the Sacramento-San Joaquin Delta. Water deliveries across the state will be affected by these increased demands and will result in less water available for consumption. After years of California using more than its allotted amount of Colorado River water, the U.S. Department Of the Interior has followed through on its promise to reduce California's entitlement to 4.4 million AFY, creating a serious crisis for southern California's Colorado River water users, and in turn, for power plant owners wishing to use that water.

DWR states in its water supply evaluation (Bulletin 160-98) that California's water use will continue to rise in the future, and that shortfalls of up to 2.4 million AFY could be expected by 2020 if conservation and various programs fail to bridge the gap.

Groundwater

Groundwater supplies are a limited and over-drafted resource in many parts of California. The demand for groundwater supplies has generally increased since 1996 and remains a relatively contentious and adjudicated resource in many hydrologic regions (DWR 1998). Because the geography and geology of California are so complex, groundwater conditions are difficult to summarize. Groundwater levels are affected by short- and long-term climatic conditions, pumping practices, irrigation return, manmade changes to recharge patterns and other factors. Ongoing overdrafts of groundwater have continued to impact water quality and in some cases caused ground subsidence. Potential adverse impacts of electric facilities to groundwater may include contributing to well interference, degradation of groundwater quality, and depletion of groundwater resources.

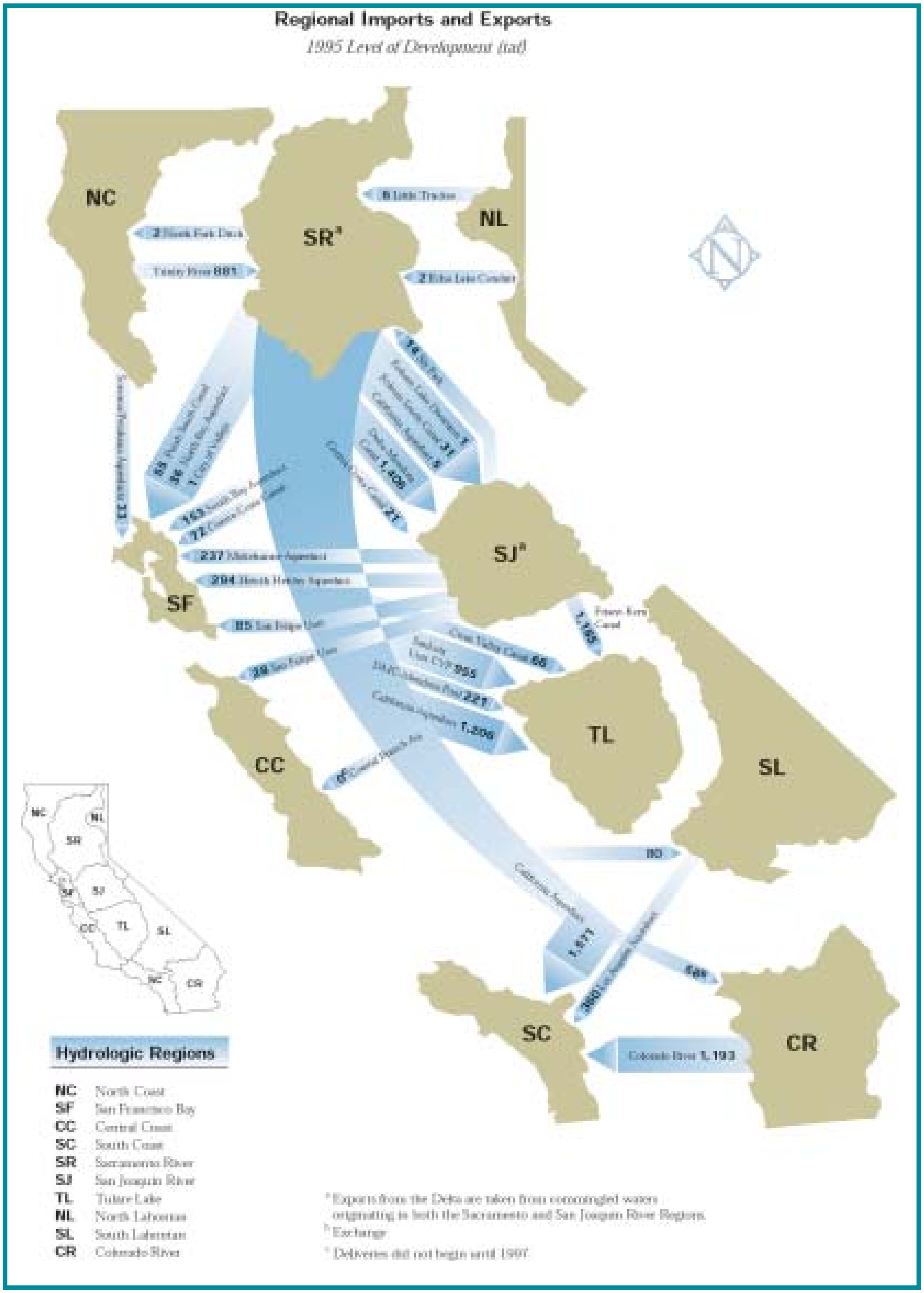


Figure III-18:
Regional Imports and Exports

Groundwater supplies approximately 30 percent of the state's urban and agricultural water demand under average conditions (12.5 million AFY), and an even greater percentage under drought conditions (DWR 1998). Overdraft of groundwater basins can affect the siting of power plants intending to use ground water.

Environmental Trends in Water Use: 1996 - 2002

The ***2001 Environmental Performance Report*** identified several trends related to water use and waste water discharge:

- a shift from coastal plant development to inland combustion turbine combined-cycled plants (500 to 1000 MW) using closed loop wet cooling systems;
- continued reliance on once-through cooling technologies for coastal facilities, even for those undergoing retrofit or replacement;
- increased use of reclaimed water for cooling in urbanized areas;
- increased use of dry cooling;
- replacing boiler units with combined-cycle units;
- increased use of zero liquid discharge systems; and
- reduced volumes of wastewater streams overall due to improved water use efficiency.

Trends in Uses of Cooling Water Types

Although older power plant designs require more water than modern more thermally efficient designs, all power plant designs require at least some water to operate. Power plant designs that are in common use today are listed below in order of greater to lesser water requirements:

- once-through cooling
- wet (evaporative) cooling tower
- wet-air cooled condenser hybrid (plume abated) tower
- wet-air cooled condenser parallel cooling towers
- air cooled condenser cooling

Since 1996, the majority of large power plants (greater than 50 MW) licensed in California have been natural gas-fired combined-cycle power plants. No new sites have been approved for once-through cooled plants. However, several coastal power plants have been modernized or refurbished while maintaining their once-through cooling processes (Moss Landing, Huntington Beach) or are seeking such certification (Morro Bay, El Segundo, Potrero).

Since 1996, 11 non-emergency thermal power plants with generation capacities over 50 MW have been brought on-line for a total of 4,516 MW. An additional 27 plants totaling 18,157 MW are currently under review or construction in California.

Only 18 percent of the capacity added between 1996 and 2002 was licensed to use fresh surface waters or groundwater for cooling, while 34 percent of the capacity that is proposed to be added or is currently under construction may use those sources. State water policy and statutory guidance encouraging the use of sources other than fresh inland waters is responsible for this trend away from the use of fresh water for plant cooling.

Table III-9:
Thermal Generation Plants > 50 MW, On-line between 1996-2002

Regional Board Jurisdiction	Fuel Type	MW Capacity	Cooling Water Source	Volume of Water
San Francisco Bay RWQCB	NG (Cogen)	240	None (Dry Cooled)	--
	NG (CC)	880	Recycled Water	5900 AFY
	NG (CC)	555	Recycled Water	4000 AFY
	NG (SM)	51	SWP (Fresh Surface)	314 AFY
Central Valley RWQCB	NG (Cogen)	171	Ground and Surface Water	1806 AFY
	NG (Cogen)	158	Surface Water	2111 AFY
	NG (SM)	91	SWP (Fresh Surface)	160 AFY
	NG (SM)	320	Ground Water (Fresh)	18 AFY
	NG (CC)	540	None (Dry Cooled)	--
Central Coast RWQCB	NG (CC)	1060	Moss Landing Harbor (Estuary)	403,200 AFY
Santa Ana RWQCB	NG (CC)	450	Pacific Ocean	283,800 AFY

Table III-10:
Thermal Generation Plants > 50 MW, Currently Under Construction or Energy Commission Review

Regional Board Jurisdiction	Fuel Type	MW Capacity	Cooling Water Source	Volume of Water (AFY)
San Francisco Bay RWQCB	NG (SM)	180	Recycled Water	560
	NG (CC)	600	Recycled Water	3,900
	NG (CC)	540	San Francisco Bay (Estuary)	255,000
	NG (CC)	600	Recycled Water	3,700
Colorado River Basin RWQCB	NG (CC)	520	Ground Water (Fresh)	3,000
	NG (CC)	520	Ground Water (Fresh)	3,300
	GE	185	Geothermal Distillate (Non-Potable)	7,000
Los Angeles RWQCB	NG (CC)	630	Santa Monica Bay	231,800
	NG (CC)	250	Recycled Water	1,400
	NG (CC)	134	Recycled Water	1,500
Lahontan RWQCB	NG (CC)	830	Banked SWP (Fresh Surface)	4,000
San Diego RWQCB	NG (CC)	510	Dry Cooled	--
	NG (CC)	500	Reclaimed Water	3,600
Central Valley RWQCB	NG (CC)	600	SWP (Fresh Surface)	2,250
	NG (CC)	530	San Joaquin River (Fresh Surface)	8,200
	NG (CC)	1100	SWP (Fresh Surface)	4,600
	NG (CC)	500	Banked SWP (Fresh Surface)	3,200
	NG (CC)	1048	SWP/Other Potable (Fresh Surface)	6,000
	NG (CC)	80	Fresh Surface	470
	NG (SM)	95	Degraded Ground Water	200
	NG (CC)	250	Recycled Water	1,800
	NG (CC)	750	SWP (Fresh Surface)	3,750
	NG (CC)	1100	Degraded Ground Water	5,340
	NG (CC)	1000	Folsom South Canal (Fresh Surface)	8,000
	NG (CC)	1120	SWP (Fresh Surface)	5,100
	NG (CC)	500	Groundwater/Dry Hybrid (Fresh)	950
	NG (CC)	500	Groundwater (Fresh)	3,300
	NG (SM)	169	SWP (Fresh Surface)	30
Central Coast RWQCB	NG (CC)	1200	Morro Bay (Estuary)	403,200
Santa Ana RWQCB	NG (CC)	1056	Recycled Water/Contaminated Ground Water	7,500

Figure III-19:
Cooling Medium for the 4,516 Megawatts That Come Online from 1996-2002

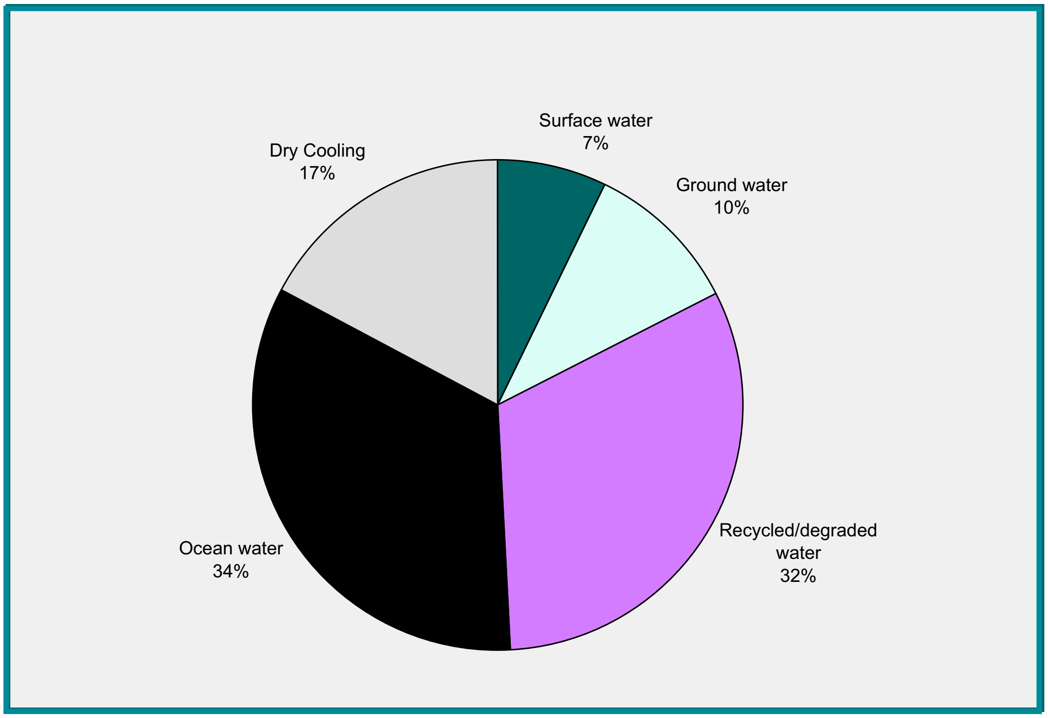
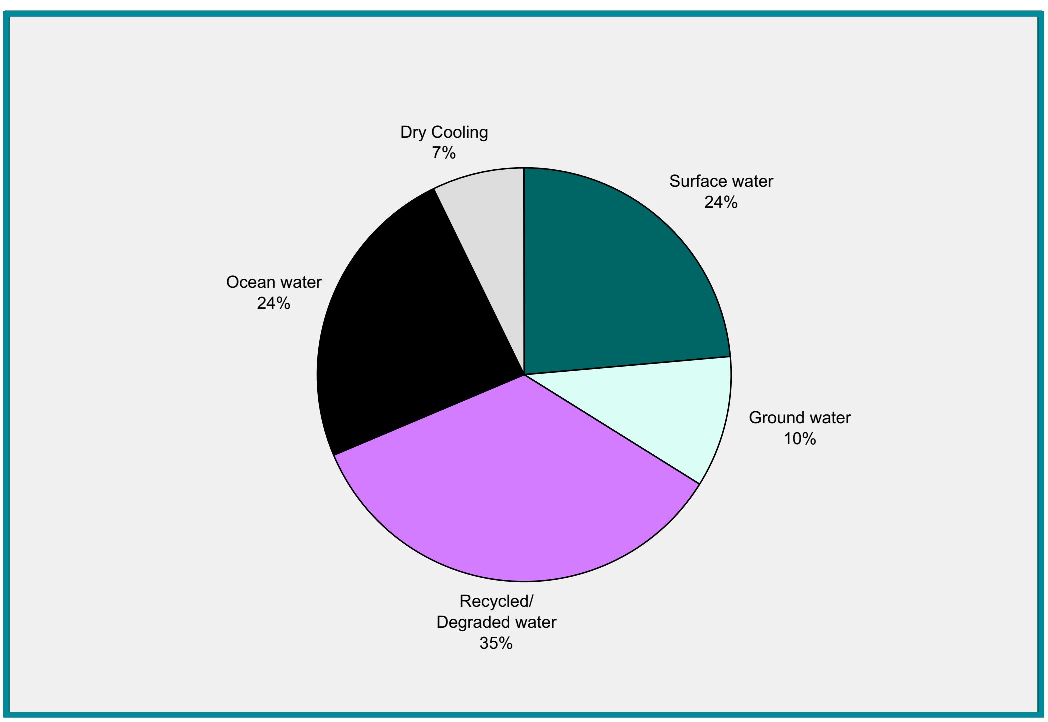


Figure III-20:
Proposed Cooling Medium for the 17,597 Megawatts That Come Currently Under Construction or Review



Alternative Cooling Water Sources Increasing

Between 1996 and 2002, California added 4,516 MW of new capacity. About 32 percent of this new power (1,435 MW) is cooled by recycled water. An additional 1,906 MW cooled by recycled or otherwise degraded water will be added upon completion of three more licensed facilities, and an additional 3,094 MW are currently in review at the Energy Commission that propose to use these sources. This marks an increase in the use of recycled water for power plant cooling compared to the number of power plants that were on line prior to 1996. The amount of recycled water available for industrial uses such as power plant cooling is increasing. In 2002, 55 of 58 counties in California had large-scale facilities for recycling wastewater. Treated wastewater is readily available in most areas of the state, and is an increasingly viable alternative to using fresh water for cooling.

Increasing competition for fresh water and the potential for new projects to adversely impact other users of fresh water has resulted in frequent consideration of alternative water supplies for cooling. Limited fresh water supplies and growing competition for these resources has lead to the development of municipal water reclamation programs that make recycled water available for power plant cooling.

Recycled Water Law and its Impact on the Siting Process

The Recycled Water Act of 1991 and related sections of the California Water Code and Constitution have had perhaps the greatest impact on the siting process from the water resources perspective. These provisions outline the benefits of using recycled water and deem the use of potable water for non-potable uses to be a waste or unreasonable use of fresh water if recycled water is available with no significant financial burden or adverse environmental impact.

Wastewater reclamation increased by 50 percent between 1987 and 2000. In 2000, the amount of reclaimed water produced was equivalent to the annual water needs of 1.6 million people (CALEPA 2002). The use of recycled water for non-potable power plant requirements is a benefit to California, and should continue and be encouraged in the future.

Emergence of Alternative Cooling Technologies

Water shortfalls are anticipated in California under average conditions, and substantial shortfalls are anticipated under drought conditions by the year 2020 (DWR 1998). The technology to reduce or avoid the use of fresh water for cooling has seen substantial increases in quality and decreases in cost. Since 1996, California has added two facilities (Crockett and Sutter) which generate power using dry cooling technology, and a third will be added when construction of Otay Mesa is completed, for a total of 1,290 MW of dry cooled-generation added. The 500 MW Three Mountain Project was licensed with a parallel wet/dry cooling system, which will use dry cooling throughout average conditions, and employ wet cooling supplementation during hot weather. These projects minimize water use to the greatest extent possible, and provide a useful benchmark for new power plant development in a state facing long-term water supply problems.

Water Quality

The State Water Resources Control Board (SWRCB) is responsible for designation under Section 303(d) of the federal Clean Water Act of “impaired” water bodies that do not meet water quality standards (SWRCB 2003). The law requires that Total Maximum Daily Loads (TMDLs) or mass discharge limitations be developed for these impaired water bodies to improve water quality. California currently has 679 bodies of water listed as impaired. The impairment of water bodies in California has been associated with both point source and non-point source pollution. Power facilities can contribute to point source pollution via wastewater discharge and the contamination of stormwater. Effluent discharged from power plants into an impaired water body is required to meet stringent discharge limits.

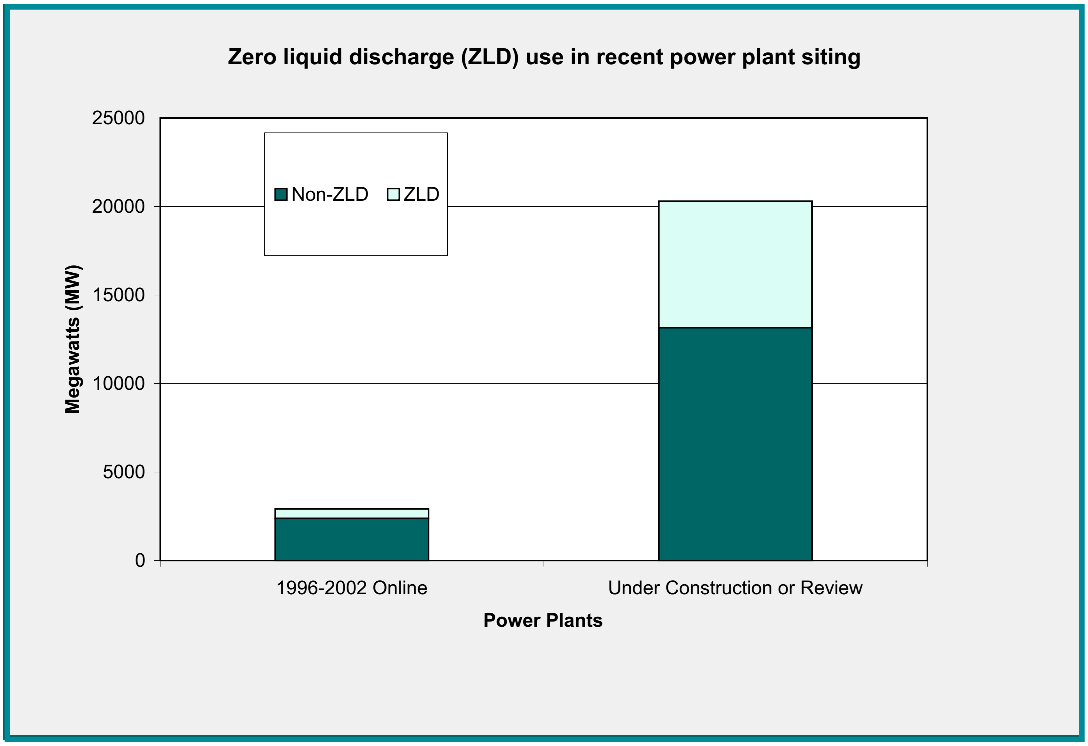
Wastewater discharges can contain chemicals that impair beneficial uses of natural waterbodies. For example, the new Mountain View Power Project in San Bernardino, is permitted to discharge nearly 300,000 gallons per day of concentrated effluent to a special industrial “brine” line. These concentrated wastes are sent to the Orange County Sanitation District’s treatment facility, which ultimately discharges to the Pacific Ocean. Other methods of discharge were infeasible because of the waste characteristics of the power plant’s wastes. The project will use a blend of groundwater and recycled water.

“Water treatment is one of the most complex aspects of modern power generation. Achieving and maintaining water quality at levels sufficient to optimize operational efficiency, avoid system upsets, and minimize potential damage to equipment and components keeps plant chemists perpetually busy tracking sample analyses, quality trends and system response.

“Increasing company pressures to reduce treatment costs, increasing community pressures to minimize water use and find alternate water sources, and increasing regulatory pressures to enhance water discharge quality all conspire to make more complex what was already complex. Among the many strategies developed in response to these challenges are the use of recycled, ‘gray’ water, zero-liquid discharge programs, and the use of enhanced demineralizer systems to reduce chemical consumption costs.” **Power Engineering, *January 2003***

The chemical composition of a waste stream is dependent upon the initial quality of the project’s water supply. Source waters may contain heavy metals or organic compounds that, if concentrated, may also pose a threat to public health or biological resources. Discharge of wastewater directly to surface water bodies can lead to degradation, especially in the case of water bodies listed as impaired under Clean Water Act Section 303(d). Discharges to land can percolate into the soil and degrade ground water resources, and waste disposal via injection wells can cause similar impacts. Because of the potential for such adverse environmental impacts, these discharges must be regulated.

**Figure III-21:
Zero Liquid Discharge Use in Recent Power Plant Siting**



Power facilities must comply with the laws, regulations and plans protecting surface water, including the Clean Water Act. The primary objective of this law is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the Clean Water Act include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand, total suspended solids, oil and grease, and pH; and "non-conventional" pollutants, such as dissolved metals.

ZERO LIQUID DISCHARGE SYSTEMS

Modern wet tower cooling systems cycle water as many as 25 times during the cooling process. When wastewater is routed through a zero liquid discharge system, the water is passed through a brine concentrator and either a drum dryer or a crystallizer. This equipment separates the chemicals in the waste stream from the water, creating a solid waste and a purified water stream. The solid waste is disposed of at a landfill or other appropriate facility, and the purified water stream is then available to be reused in the facility. This recycling offsets additional water supplies that would be needed if the waste stream was discharged conventionally, conserving water and preserving water quality. Because of effluent limits contained in their NPDES permits, many power plants do not use water to maximum efficiency because they cannot discharge water with elevated levels of some constituents. However, zero liquid discharge systems sidestep issues of both quantity and quality of discharge, and can reduce cooling water demand by as much as one fifth.

Power plant facilities require a number of hazardous materials and waste to be handled and stored onsite. Because hazardous materials and wastes were not as well regulated in the past as they are today, many power plant sites have contaminated soils and groundwater from leaks, spills, and releases associated with historic activities (CPUC 1998a).

One recent trend is the increased use of zero liquid discharge systems, which can be incorporated into facilities to eliminate wastewater discharge problems. Power plant developers can employ measures to further increase the water efficiency in modern power plants.

Of the 27 projects that are currently under construction or are still in the review process, nine have proposed or would be licensed with a zero liquid discharge system. **Figure III-21** shows the total number of megawatts in projects with and without zero-liquid discharge systems that came online between 1996 and 2002, and among projects currently in construction or under review at the Energy Commission. This is a positive trend that increases the efficiency of power generation with respect to water in California.

Regulatory Trends

Clean Water Act 316(b) Regulations

Cooling water intake structures can cause injury or death to fish or other aquatic organisms by entrainment and impingement. Section 316(b) of the Clean Water Act requires EPA to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. On December 18, 2001, EPA issued the final rule governing cooling water intake structures for new facilities. The Phase II rule for existing intakes was proposed in 2002, with final regulations expected by 2004 (NPRA 2003).

These regulations typically apply to coastal power plants, as those are the primary users of once-through cooling technology in California's power generation sector. The details concerning how these regulations are implemented will affect plans to modernize existing coastal power plant projects in California.

Impaired Water Bodies

As discussed above, many water bodies or portions of water bodies in California are identified on the Clean Water Act 303(d) list as water quality impaired with regard to designated beneficial uses. While these water bodies are located throughout the state, they frequently coincide with heavily developed or farmed areas. In general, these lists are increasing in size rather than shrinking, meaning that more bodies of water do not meet water quality standards.

Power plants discharging wastewater either directly to impaired receiving waters, or indirectly to receiving waters through a wastewater treatment plant could face more stringent effluent discharge limitations or pretreatment requirements. This puts restrictions on discharges from power plants, sometimes forcing projects to use zero liquid discharge technology to avoid adverse environmental impacts to surface waters. Increased emphasis on best management practices to control pollution from stormwater runoff has had positive benefits.

California Hydropower and Water Quality Impacts

California has 386 existing hydroelectric plants, each with one or more generating units making up an installed capacity of 14,116 MW. The capacity of a hydroelectric project can vary significantly from less than 0.1 MW to over 1,212 MW at PG&E's Helms Pumped Storage Project, and even greater outside California, such as Grand Coulee Powerhouse on the Columbia River rated at 6,809 MW.

California hydropower provides about 15 percent of the state's electricity in a normal water year. While generally considered a clean technology due to the lack of criteria pollutants emissions and greenhouse gas emissions, hydropower operations impact the ecosystems of rivers and streams and diminish the water quality characteristics needed for fish and other aquatic biota. These impacts include altered river systems resulting from the change to natural river flows, altering aquatic habitats, dewatering sections of streams, blocking the migration of fish, changing water temperatures and flooding land and adjoining upland riparian areas.

The key water quality parameters for hydropower are temperature, flow volume, suspended solids and dissolved oxygen levels. Cold water fish such as trout and salmon require the right balance of temperature, flow volume and oxygen to maintain viable habitat conditions. Cold water fish require water temperatures of 20 degrees Centigrade (68 degrees Fahrenheit) for most life stages. Water temperatures in bypass reaches often exceed those levels and are lethal to cold water fishes. Sediment and gravel transport are factors in maintaining the physical suitability of channels and stream bottoms for spawning and foraging. Water that passes through hydroelectric turbines is classified as a "waste discharge" under the federal Clean Water Act. The California SWRCB regulates such waste discharges through Section 401 of the act, and sets water quality standards to protect the beneficial uses of water in California.

FERC licenses and regulates 119 projects in California, totaling 11,930 MW. Twelve power plants representing 2,186 MW are federally-owned projects which are not subject to FERC licensing, but benefit from improvements from programs such as the Central Valley Project Improvement Act and Cal-Fed.

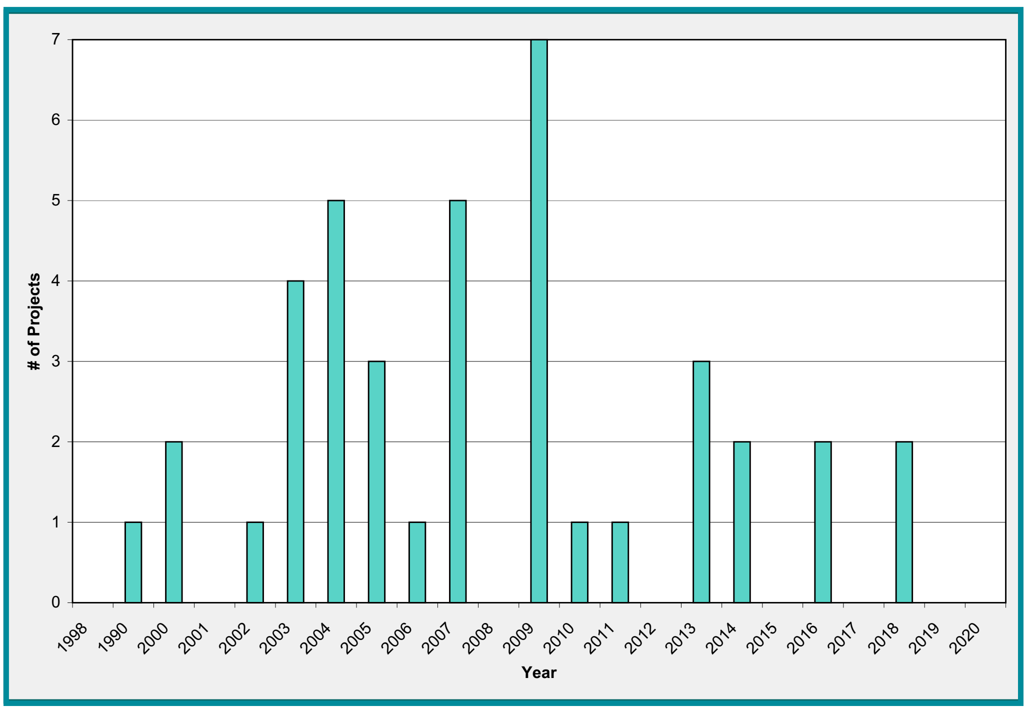
FERC hydropower licenses are issued for 30 to 50 years. The original licenses generally contained no provisions to monitor water quality and aquatic biological conditions and had no provision to change operational practices in response to new scientific understandings of impacts. Rivers were treated as linear water conveyance systems, as opposed to complex, dynamic ecological and physical systems. In accordance with the scientific thinking from the mid-20th century, FERC generally set instream flow levels and release schedules at low, static levels intended to optimize power production from each stream and river segment (SWRCB 2003a).

Under the Federal Power Act, a FERC project license incorporates the regulatory standards that were in place when the license was issued. This means that the many older California hydropower projects conform with the Federal Power Act, but do not conform to current state regulatory standards or to current federal Clean Water Act or Endangered Species Act standards. As of 2003, only a small portion of California's hydropower system meets current state water quality standards**.** Six of the 119 FERC-licensed projects have 401 certification under the Clean Water Act from the State Water Board, and three more are nearly complete. These nine projects total

275.3 MW. A large portion of California's hydroelectric system will be relicensed in the near future, which creates opportunities to bring a key part of California's energy sector into conformance with current state and federal environmental law. Between 1998 and 2020, 40 projects representing 5,241 MW (37% of California's hydropower capacity) are undergoing or scheduled for environmental review through FERC relicensing and SWRCB Section 401 water quality certification. Relicensing provides the opportunity to improve environmental protection measures and initiate adaptive management principles, a trend for continuous and progressive environmental improvements to hydro facilities and to develop in the coming decade.

Modern FERC relicensing conditions include a host of protection, mitigation and enhancement measures addressing goals, objectives and strategies tailored for management of the individual ecosystems. Below are examples of the types of environmental goals and objectives managed under the adaptive methods established in these relicensing agreements.

**Figure III-22:
California Hydro Projects Scheduled for FERC Relicensing & SWRCB401 Certification 1998-2020**



(Ref: U.S. Dept. of Energy, http://hydropower.inel.gov/facts/license.html)

A FERC licensed hydroelectric project may be comprised of one or more powerhouses.

Fisheries – Establishing criteria such as fish population, species and densities in pounds per mile or pounds per acre, age classes, average size caught, average catch rate in number of fish per hour, macro-invertebrate indices (as available food for fish);

Natural hydrograph and stream environment – Establishing flow rates below powerhouses or in bypassed reaches of streams to better mimic natural conditions, maintaining natural fluvial processes and riparian habitat, and to prevent unnatural fluctuations that could affect biota or public safety; and

Other beneficial uses – Providing stream flows that provide broad recreation opportunities including whitewater boating where applicable, and that maintain the economic viability, reliability and flexibility needed for effective power production.

Please see the Biological Resources section for additional discussion of hydropower issues. Energy Commission staff will also publish a white paper on hydropower issues as part of the Integrated Energy Policy Report.

Electric and Gas Transmission Systems

Pipeline and underground power and transmission line construction projects, as well as substation and pump station construction projects, can cause erosion of soils and lead to increased sedimentation of nearby surface water bodies. Best management practices exist that can reduce or eliminate these impacts when properly implemented.

Water Contamination

Historically hexavalent chromium (chromium 6) was added to water towers at natural gas compressor stations to inhibit corrosion. This practice resulted in groundwater contamination. Chromium 6-contaminated groundwater is highly toxic to organisms and plants (LARWQCB, 2003). This practice is no longer followed.

Polychlorinated biphenyls (PCBs) were widely used in electrical transformers because of their excellent temperature-insulating abilities. It is believed that human exposure to PCBs can cause chloracne (a painful, disfiguring skin ailment), liver damage, nausea, dizziness, eye irritation, and bronchitis (EH&S 2003). Old transformers with a nameplate prior to 1978 may contain PCBs. If

> Most western states scrutinize water use by power plants although none have policies as direct as California's policy (SWRCB Resolution 75-58), which states that the use of fresh inland waters for power plant cooling is only warranted when the use of other water supplies or other methods of cooling would be environmentally undesirable or economically unsound. The federal EPA has no specific policy or directive regarding power plant water use. The EPA generally comments on power plants undergoing federal National Environmental Protection Act review and requests that dry cooling be given consideration as an alternative to wet cooling.

they leak, they can spread PCBs into the environment (LLNL 2001). The Federal Toxic Substances Control Act of 1976 made it illegal to buy or sell PCB containing materials within the United States.

Imported power

Electricity imported to California can cause water-related impacts in the state or location it is generated. California typically imports power from the Pacific Northwest, the Desert Southwest, Canada and Mexico. The degree to which water use is a critical policy issue in each of these areas differs both due to generation technology, climate, population, and local priorities.

Northwest Power

Hydropower accounts for the majority of electricity (66 percent) generated in the Northwest, followed by coal (18 percent), natural gas (7 percent), nuclear (5 percent) and biomass (4 percent) (NWPPC 1998). The Northwest region includes portions of the Columbia, Klamath and Bear River basins and the Puget Sound and coastal drainages of Oregon and Washington. Measures undertaken since 1991 to improve the survival of fish in the Columbia River Basin have resulted in the loss of 850 MW of firm energy capability.

For thermal power plants using water for cooling, there are no policy or legislative directives regarding water use by power plants other than the Washington Department of Ecology requirement that "all known and reasonable technology " be utilized (Makarow, per. comm. 2003). The Department of Ecology is responsible for making decisions on applications for new water rights, and changes and transfers to existing water rights and in so doing frequently advocates air cooling over water cooling for new power plants. The 520 MW Chehallis facility is the only thermal plant in the state using dry cooling.

Power plants in Idaho are licensed by the Idaho Public Utilities Commission, which has no policies or regulations regarding water use (Randy Lobb per. Comm. 2003). One natural gas facility (275 MW), currently on-hold, had proposed to use advanced air-cooled condensers to reduce water consumption, due to concerns regarding impact to municipal water supplies. Recently, a proposed natural gas plant near the Washington-Idaho state line was denied a permit to take 7 million gallons of water a day from the Spokane Valley-Rathdrum Prairie Aquifer, considered to be the sole source of drinking water for 400,000 people (seattlepi.com 2002).

No specific policies apply to water use by power plants in Oregon. All combined-cycle natural gas plants currently operating or approved for construction in Oregon use wet cooling.

Rocky Mountain Power

Coal-fired power plants dominate the Rocky Mountain region. The Rocky Mountain region covers almost the entire state of Colorado, about two-thirds of Wyoming and small portions of Nebraska and South Dakota. In addition to impacts to water resources associated with power plant cooling requirements, the deposition of emissions (including mercury) and discharge of wastewater from coal-fired plants can also affect water quality. Three of the four coal-fired electric power plants in the Northeast Wyoming River Basins planning area (combined generating capacity of 430 MW) use air cooling rather than water cooling because of limited surface water availability. The plants use about 500 acre-feet of water annually, and most is obtained from the Gillette sewage treatment plant. In contrast, the only water-cooled facility in the area uses about 400 acre-feet of water annually to generate 33 MW of electricity (Wyoming State Water Plan, 2002). Additional power plants proposed for the area will also involve dry cooling towers and limited use of groundwater for process purposes. Wet cooling towers are in use at other locations in Wyoming that have adequate surface water supplies.

Coal-fired power plants provide the major portion of Colorado electricity, followed by natural gas and hydroelectric generation facilities. No state policy or directive addresses water use by power plants (Winger per. comm. 2003).

Southwest Power

Coal-fired power plants dominate in the southwest followed by hydroelectric, nuclear, and natural gas. Water use associated with power plants in the southwest is driven by water availability and price.

Arizona Revised Statutes Section 40-360.13 requires that the Arizona Power Plant and Transmission Line Siting Committee consider the availability of groundwater and the impact of the proposed use of groundwater as a criterion for issuing the Certificate of Environmental Comparability. The Committee has not required the use of dry cooling to date (Williamson per. comm. 2003). Power plant applications must be formally approved by the Arizona Corporation Commission. In 2001, that Commission denied an application by Caithness Big Sandy LLC to develop a 720 MW electric generating plant near Wikieup in western Arizona because of its effect on scarce water supplies. The 1800 MW Toltec Power Station was also denied a permit, in part because of concerns regarding excessive groundwater pumping. Major coal deposits in Black Mesa, Arizona require over one billion gallons of potable groundwater each year used to create a slurry that is pumped through a pipeline to a power station in the Mojave Desert.

Environmental Performance Report
Chapter 3
Environmental Performance: Cultural Resources

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Cultural Resources

California has been the home for approximately 90 Native American language groups that incorporated several hundred dialects. The Spanish and Mexicans explored and settled early California. The discovery of gold brought an influx of large numbers of Euro-Americans and many immigrants of Chinese, African-American and European origin. From the early 1900s to the present day, immigration has increased the human diversity in California. The search for a better life also brought immigrants from Japan, the Philippines, and South America and elsewhere. With California's rich cultural history, cultural resource evaluations for energy facility siting cases have frequently involved mitigation for known and previously unknown archaeological and other cultural resources.

Since its inception, the Energy Commission has applied State laws and guidelines in its evaluation of proposed energy facilities around California. The Commission has also looked to federal law and the U.S. Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation for guidance in the mitigation of impacts to cultural resources. These are the appropriate professional methods and techniques for the preservation of archaeological and historic properties.

Four primary cultural resource issues can arise during an energy facility siting case:

- prehistoric and historic era archaeological resources, both known and unknown (under ground);
- historical resources present in the built environment (45 or more years old or determined exceptional with specific qualities defined in the Public Resources Code 5024.1);
- ethnographic resources (materials or areas important to the heritage or religion of a particular ethnic or cultural group such as Native Americans, or particular immigrant groups); and
- Native American sacred sites and areas of traditional concern, which can be particularly sensitive aspects of ethnographic concerns, since more than one tribe may declare a portion of a landscape or geographic location to be a sacred or traditional site for their tribe.

Recently, Native American tribes have pursued legislation to provide more control to the tribes for development activities on or near sacred sites. To date, no such legislation has been enacted. The Energy Commission, with guidance from the Native American Heritage Commission and the California Environmental Quality Act, treats any organized Native American group as a governmental entity. In cases where more than one group asserts traditional use of an area, the Energy Commission addresses the concerns of each affected group enabling them, to the extent possible, to address concerns regarding their culture(s).

Most of the 68 energy facilities approved for construction and operation by the Energy Commission to date, and most of the 17 facilities that were approved after 1996 and became operational prior to December 31, 2002, involved one or more of the primary cultural resource issues described above. Several cases have involved two or more of the four issues. In one case, a new power plant was proposed on the site of an existing power plant that is more than 50 years old.

The existing power plant was determined to be a historically significant structure that required mitigation prior to demolition. It was also determined that the original plant had been built on top of a Native American archaeological site that contained human remains and that also required specific mitigation. Moreover, an adjacent natural feature was declared sacred to more than one group. In addition, two Native American tribes (composed of several bands) declared the power plant area to be their ancestral lands.

One of the most significant cultural resource finds is the discovery of previously unknown Native American burials during construction. The procedures and treatment of such finds is well documented in State law, including required contacts with the county coroner, Native American Heritage Commission and the selection of a Most Likely Descendant for Native American group(s) with traditional ties to the human remains. The treatment of human remains and associated burial goods is identified in law, but the treatment of archaeological finds in general is at times the subject of disagreement between Native American groups and archaeologists. The desire to protect underground cultural resources from disturbance is one of the primary motivators for the movement toward the legislation described above.

An issue that creates difficulty for permitting agencies is the need to obtain information about various historic Native American sites from Native American representatives. In order to continue practicing their religion and other cultural traditions without interference, details of the nature and location of the resources must remain confidential. A mechanism needs to be established that would facilitate the consultation, recordation, and any required mitigation for these resources. In keeping with these goals, supporting the proposed traditional tribal cultural sites bill would facilitate development while protecting traditional Native American resources.

Environmental Performance Report
Chapter 4
Societal Effects of Electric Generation

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Chapter 4
Societal Effects of Electric Generation

This chapter examines the local societal effects of California's electric generation system. This assessment considers both the socioeconomic benefits and drawbacks of generating facilities in California, and also examines the land use compatibility issues that can arise from this type of facility and the environmental justice concerns that often arise in the permitting of new facilities. This chapter also briefly examines the change in economic and demographic conditions in the vicinity of the largest power plants in the state from the time they were initially brought online.

Land Use

Summary of Findings

- Forty percent of Energy Commission siting cases from 1996 to 2002 required a general plan amendment or zoning change, or other local actions.
- In rapidly growing urban areas, energy infrastructure development and repowering often occurs very close to sensitive community resources such as new residential areas, schools, and recreation areas, which can lead to intense controversy and delay the facility siting process.
- Existing coastal power plants are generally located in areas that have experienced significant development and residential growth, and the repowering of those projects has caused and is likely to continue to cause local debate and controversy.
- Local and regional land use and development planning efforts seldom designate sites or corridors for energy facilities such as electric power plants and transmission lines, and energy facility proponents are seldom involved in these long range efforts.

Introduction

New energy facility proposals and project alternatives can conflict with existing local land use plans. Such conflicts have led to community controversy and delays in specific power plant siting cases. Power plants and electric transmission lines are frequently overlooked in land use planning activities such as updating a general plan, a zoning revision, or the formulation of specific plans for residential and school developments.

These land use conflicts can be particularly acute in areas with rapid population growth. Regions with high growth have an increasing demand for electricity, which may make them attractive areas for new power plants. The rapid growth may also result in the development of residential areas and sensitive uses, such as schools, being approved close to zones designated for industrial or infrastructure development with little or no buffer of less intensive land uses. Home and business owners frequently object to new power plant proposals as examples of bulky, "smokestack" industries, and note that the addition of a large electric transmission line could adversely affect a residential area's scenic vistas. While the direct impact of energy facilities in terms of acres of land converted is relatively small on a state-wide basis, new or expanded energy facilities are often considered incompatible with existing and planned land uses and can result in serious land use concerns on a local basis.

Land Use and Energy Facilities

Land Use and Acreage Information

Energy facilities occupy only a small portion of the total land in California. **Table IV-1** provides an overview of the acreage distribution of different types of land within California. Electric generation facilities occupy less than 0.1 percent of the state's land, and transmission facilities are estimated to occupy approximately 0.75 percent. **Table IV-2** summarizes the available information on the amount of land that had been converted to different types of power generation uses in 1996 and 2002.

What is Land Use?

The term land use encompasses several concepts:

- The ***physical amount of land*** (usually expressed in terms of acres) that is occupied by an existing structure and related facilities, such as an electric power plant and a switchyard connecting it to the electric transmission system;
- The type of ***activity that is currently occurring*** on a piece of land, such as irrigated crop production, urban uses such as residential or commercial development, schools, industrial and manufacturing processes, and infrastructure to support urban uses such as wastewater treatment facilities and landfills.
- The type of ***activity that is planned*** for a piece of land, such as residential or industrial, which can include electricity generation, through a city or county general plan for long range development; or the local zoning process which generally provides detail on specific uses permitted in each planning area;
- The ***consistency*** of a proposed project such as an energy facility with a local general plan, and ***conformance*** with a city or county zoning ordinance;
- The ***compatibility*** of a proposed project such as an electric power plant or transmission line with the current and planned uses in a city, county, or broader region.

A buffer zone of open space or less intensive uses such as rental storage units can help ensure compatibility between large industrial uses such as power plants and more sensitive uses such as residences, schools, and hospitals. Unfortunately, often little or no buffer between industrial land uses and sensitive uses is provided. The land use **compatibility** concept can be complicated as community members raise concerns about air quality, facility noise and other impacts. Given their perception of these potential impacts, they often conclude that a power plant would not be compatible with nearby uses such as a recreation area, a small business zone, or a residential neighborhood. Therefore, a land use compatibility issue can arise which is linked to community apprehensiveness about the other potential impacts.

Table IV -1:
California Acreage Profile

Total California acreage:	100,000,000 acres
Federally owned or administered land:	50,000,000 acres
Agricultural land:	23,500,000 acres
Other land:	11,600,000 acres
Water area:	670,000 acres
Urban and Built-Up land use (rising by approx. 100,000 acres/year):	3,500,000 acres
Electric generation facilities:	12,700 acres*
Electric transmission facilities:	758,100 acres**

*does not include area covered by hydro power reservoirs, area within wind farms not occupied by turbines, or area of landfills where methane is collected for combustion in waste-to-energy facilities.

**based on 31,270 miles of line and assuming a 200 foot right-of-way
Data Sources: William Fulton, Guide to California Planning, and Appendix III-2.

Basic data on the number and acreage of non-electric energy facilities found in each county, such as oil and gas wells, and oil storage tank farms is not currently available on a statewide basis. Similarly, state wide summaries of land use data, such as the previous land use, general plan designations, and zoning classifications, is not available. The availability of acreage data for electric facilities is uneven. Information on land use of sites for all energy facilities before they were actually approved would enable assessment of the extent of the conversion of resources such as prime agricul-

Table IV-2:
Approximate Land Acreages Converted By California Power Generation Facility Sites (1996 & 2002)

Type Of Facility	1996 Number Of Units	1996 Acreage	Number Of Units Added 1996-2002	Acreage Addition 1996-2002 (percent)	2002 Total Acreage
Oil/Gas	366	5,264	33	212 (4%)	5,476
Coal	15	201	0	0	201
Hydro[1]	386	900	0	0	900
Solar: (total)		2,035			2,035
- Thermal	8	2,004	0	0	2,004
- PV	5	31	Unknown	74 (238%)	104
Nuclear	2	353	0	0	353
Wind [2]	89 farms	47	0	-6 (-13%)	40
Geothermal	45	422	0	0	422
WTE[3]	105	1,086	Unknown	65 (6%)	1,151

1 Does not include area covered by reservoirs. Including reservoirs, the total would be approximately 267,000 acres.

2 Includes only land covered by wind turbine facilities themselves, which generally occupy less than ten percent of the total land area in a wind farm. Other areas within the wind farms are often available for use in agricultural operations, open space and/or wildlife habitat. While some wind turbines were removed in the late 1990s, new wind development has begun since 2000. Total acreage of the wind farms was approximately 8,300 acres in 1996 and had not changed by 2002, though new wind development was beginning to be installed. In 1996 and as of the end of 2002, there were five major Wind Resource Areas – Altamont Pass in Alameda Co.; Pacheco Pass area in Santa Clara and Merced Counties; San Gorgonio Pass in Riverside County; various areas in Solano County; the Tehachapi Range in Kern County, and several smaller areas.

3 Does not include the area of landfills where methane is collected for combustion in waste-to-energy facilities. With the landfill areas included, the total would be approximately 11,000 acres for 1996 and nearly 15,000 acres for 2002.

tural land, and how many projects were consistent or conflicted with local land use plans. Because land use planning and zoning decisions are made at the local level, this type of land use data is not typically collected in a centralized system.

California's Land Use Permitting Process

Most land use decisions (*i.e.*, project-specific approvals for development, and general plan and zoning update decisions) for projects proposed in incorporated areas within city limits, are made by elected city council members in California's more than 400 cities. Similarly, land use decisions on projects proposed in the unincorporated areas within the state's 58 counties, are made by elected boards of supervisors. Forty percent of the power plant projects licensed by the Energy Commission between 1996 and 2002 have conflicted with local general plan and zoning decisions for the sites.

The lack of local or regional long range planning for facilities such as power plants, and the difficulty of coordinating any statewide energy facility planning process with local land use planning processes, has been a factor in some extremely protracted and controversial licensing proceedings. Because major energy facilities are typically not considered when local long-range development plans are updated, community concern over potential environmental impacts of these facilities is generally voiced when specific projects are proposed. In addition to the problems resulting from energy projects conflicting with local general plans and zoning, the overall responsibility for permitting energy facilities in California is fragmented, which has led to energy and land use data collection challenges, and inconsistent approaches to permitting processes.

Land Use Status and Trends

Geographic Distribution of Electricity Facilities

The ***2001 Environmental Performance Report*** presented data on California's place as an electricity producer and consumer within the western states, and the distribution of electric plants within the state. Los Angeles, San Diego, Contra Costa, and San Luis Opispo Counties have the largest amount of installed generation. San Bernardino and Kern Counties are also major electricity producers. Sixteen of the state's 366 oil/gas facilities are located on the Pacific coast, and five are located on San Francisco Bay and the adjoining Carquinez Strait/ Suisun Bay.

Electric Power Plant Siting in California from 1996 to 2002

Between 1996 and 2002, the California Energy Commission approved licenses for 33 natural gas fueled, thermal electric generating facilities (hereafter referred to as the 33 facilities) under its permitting/licensing authority. This analysis (see Land-Use/Land Conversion Table in **Appendix IV-1**) looks at all the 33 facilities licensed, which, if all were completed, would at build-out use 462 acres of land state-wide. If all of these facilities were operating, they would contribute approximately 13,266 MW into the state power grid. Electricity market uncertainties and project financing issues have caused delays in the construction of seven of these facilities. The 462 acres does not include linear facilities such as electric transmission lines, gas and water pipelines, areas used temporarily for construction material and equipment storage, and construction worker parking.

Who Permits and Licenses Energy Facilities in California

- The California Energy Commission's permit is in lieu of all state and local permits for thermal electric generation facilities that are at least 50 megawatts in size, and for facilities directly related to those generation projects such as electric transmission lines, gas pipe lines, and water lines.
- Local air pollution control districts often have a major role in permitting small power plants, and large energy facilities that are not electric power plants, such as additional processing units at oil refineries, due to the air emissions associated with facility operation. The air districts' permits are among the many required at the local government level, which does not have a unified energy facility permitting process. The air districts work with the Energy Commission on air quality permit issues associated with large power plant proposals that are under the Commission's jurisdiction.
- City and county elected officials and numerous local agencies are responsible for approving non-thermal generation facilities other than hydroelectric facilities, such as wind turbines, and thermal generation facilities that are less than 50 megawatts in size, such as natural gas-fired, geothermal, and waste-to-energy power plants.
- The California Public Utilities Commission permits electric transmission lines proposed by California's investor owned utilities, unless they are connected to a thermal power plant under the Energy Commission's jurisdiction.
- California's municipal utilities are responsible for permitting the transmission line projects that the lines propose, unless they are connected to a thermal power plant proposal under the Energy Commission's jurisdiction.
- Gas pipelines are permitted by varying entities depending on which government entity is most affected. A pipeline crossing over state owned lands and/or navigable bodies of water could be permitted by the State Lands Commission. If the pipeline originates in another state and crosses into California, the Federal Energy Regulatory Commission could be involved.
- Jurisdiction over liquified natural gas facilities, which are currently not found in California, is uncertain and under discussion at the state level. Details of a particular proposal would affect what agency was the lead under CEQA, and the role of other agencies.

Lands used for the construction of the 33 facilities included agricultural lands with recent crops, producing oil fields, a former military base, vacant industrial parcels, and existing power plants or substation sites. Power plant sites ranged in sized from 0.67 acre to 76 acres. The vast majority of new facility sites involved land that was developed for some type of urban or infrastructure use, or it had been developed in the past, with the generation facility placed on land designated for redevelopment.

Land Use Characteristics

Land Use **Appendix IV-1** presents land use features of the 33 electric power plants permitted and licensed by The Energy Commission between 1996 and 2002. The sites used for these facilities were categorized as green field, intermediate or brown field.

Green field

Green field sites are those that were agricultural crop producing land (*e.g.* row crops, vineyards, or orchards), range land, forest, and open space land. Local jurisdictions often seek to preserve agricultural land and open space for a number of reasons. Agricultural lands may serve as an economic base. Green field lands also help retain lower densities, provide a jurisdictional buffer or green belts, serve as a population growth management strategy, protect species habitat, provide outdoor recreation, preserve scenic views, and provide other benefits.

The siting of new energy facilities of any size away from an urban/population center can result in the use of land designated by a local jurisdiction for agriculture, and thereby contributes to the cumulative loss of productive farmland for the local jurisdiction and state as a whole. Seventy-one acres of agricultural/open space land has been or will be permanently converted statewide for the building of four new generation facilities (this figure assumes that agricultural lands temporarily removed from production due to construction activity will be returned to farming). While this is a small fraction of the total agricultural land in the state, conversion of agricultural land for energy facilities often occurs in areas where rapid development is already placing pressure on local agricultural land, so the conversion may be important at the local level. In addition, two facility sites required the project owner to obtain a cancellation of a California Land Conservation Act (commonly know as the Williamson Act) contract on the project site in order to build. Power generation facilities are not permitted on land that is subject to an executed Williamson Act contract. A power plant is not a use consistent with the “principles of compatibility” for uses on contracted land (Government Code Section 51238.1). Agricultural land totaling 51 acres has been subject to contract cancellation by affected local governments in order to allow power plant development.

Intermediate

Intermediate sites are those that, at the time of the permit application, were moderately disturbed, moderately improved or developed, or moderately distressed. These sites had limited infrastructure, and existing mixed land uses may have surrounded site. The tax assessment of these sites as conducted by the County Assessor was not based on virgin land, farmland, or open space land. Sixteen of the sites, totaling 222 acres, were categorized as intermediate.

Brown Field

Brown field sites are those that were highly disturbed, improved, or developed with available infrastructure. These sites may have been blighted or distressed. Many of these projects were in-fill development in an urban area. Thirteen facilities are being built on 169 acres of land categorized as brown field. One of these facilities, High Desert, was built on the former George Air Force Base, near Victorville.

Proximity to an Educational Facility

Eight of the 33 facilities were sited within one mile of an educational facility. California Department of Education Guidelines state that new school sites should be at least 1500 feet away from existing uses such as large electric transmission lines, gas pipelines, and power plants.

Four of the eight facilities were peaker projects (*i.e.* gas-fired, simple cycle generation units designed to run during periods when electricity demand is very high) licensed during the 2000/2001 energy crisis. Community concern with air quality, public health, and hazardous materials issues was a factor in three cases in which proposed schools were located within one mile of a power plant site, which resulted in a land use compatibility issue.

Schools, with their juvenile populations, are sensitive land uses often associated with new residential urban development. In counties with rapid population growth such as Placer, San Joaquin, and Riverside, new residential areas with school sites have been approved near zones designated for industrial/infrastructure uses such as power plants. In some cases little or no buffer of less intensive land uses has been left between the two areas.

Power plant developers have generally not involved school district officials in preliminary discussions regarding their proposed sites, which has resulted in community controversy and proposed legislation regarding power plant siting near schools.

Consistency with Local Laws, Ordinances, Regulations, and Standards

Forty percent of the electric power plant facilities licensed by the Energy Commission between 1996 and 2002 required an amendment to a local general plan or change of zoning designation, because the proposed site was slated for a different use such as residential/commercial uses or agriculture. One application required the Energy Commission to override the local government's land use authority to allow the siting of a thermal electric generating facility.

Local Land Use Compatibility and Community Controversy

Local governments have sometimes approved new residential areas and school sites near heavy industrial or infrastructure zones that would permit uses such as power plants and large overhead electric transmission line corridors. Overhead transmission line projects have the potential to divide a growing urban area and can be difficult to site. These land use issues have sometimes been linked with community concern over visual impacts, air quality emissions, and facility noise, which have led to overall land use compatibility problems. Residents' perception about the project being incompatible or a "poor fit" in their neighborhood often triggered community controversy and project delay. The controversy has been particularly intense in counties experiencing rapid residential growth such as Placer, San Joaquin, and Riverside Counties.

Since 1996, the Energy Commission has reviewed several power plant proposals where a City Council or County Board of Supervisors adopted a resolution and/or ordinance that opposed the siting of the power plant within their jurisdiction, or chose not to approve the required leases of local government property to allow the siting of the project. The Energy Commission has override authority to permit projects that are not consistent with local laws, ordinances, regulations or standards, though it has rarely used that authority. The Commission cannot, though, require a local agency to execute a lease for a site. The inset below highlights two such examples of local controversy.

Local land use planning processes do not always succeed in addressing the regional need triggered by population growth for new infrastructure such as transmission facilities. Large, overhead transmission projects have the potential to affect scenic views and divide a growing urban area, and can be very difficult to site. These types of land use issues have often triggered community controversy and project delay.

City and County of San Francisco

The Energy Commission issued the proposed United Golden Gate power plant project a license to construct and operate. However, El Paso Energy (project owner) has not been able to obtain a lease agreement from the San Francisco International Airport Commission in order to construct the facility on the airport's property.

The San Francisco Board of Supervisors enacted San Francisco Ordinance 124-01 "Human Health and Environmental Protections for New Electric Generation" on May 21, 2001. The ordinance was created in response to community concerns over the proposed construction of a new 540-megawatt unit at Mirant's existing Potrero power plant facility located in the southeast sector of the City of San Francisco. The ordinance directed the San Francisco Public Utilities Commission and the Department of Environmental Protection to adopt an energy resource plan that considers all practical transmission, conservation, efficiency and renewable alternatives to fossil fuel electricity generation in the City and County of San Francisco. Currently the City/County is working on the development of several peaking generation facilities with sites yet to be identified.

Nueva Azalea Power Plant

The Nueva Azalea Power Plant project was being proposed in the City of Southgate. The Southgate City Council adopted a resolution opposing the power plant project. A citizen's initiative was approved by the residents of Southgate prohibiting future power plant siting within the city. Sunlaw Cogeneration Partners (applicant) chose to concede to the initiative and withdrew their application instead of continuing with the processing of their application with the Energy Commission.

Energy Commission staff needs to work with local and regional government staffs to help integrate both power plants and transmission facilities into the local general plan process and related regional planning activities. This liaison work with local and regional planners should include use of energy facility/urban planning tools, such as PLACE3S, that can help identify a preferred plan for a long term mix of land uses including energy facilities such as electric power plants and electric transmission lines.

PLACE3S
PLAnning for Community Energy, Economic and Environmental Sustainability (PLACE3S) is a regional and urban planning tool designed to help communities discern an effective path toward natural resource and energy sustainability, and make land use choices for the future. It uses the power of Geographic Information System data and innovative Internet access to sophisticated software to quickly evaluate how efficiently a region uses its land, provides housing and jobs, moves people and materials, and provides public infrastructure. PLACE3S integrates state-of-the-art public participation, urban planning and design, and quantitative measurement into a five step planning process appropriate for regional and neighborhood-scale assessments. It enables citizens, local elected officials, planning staffs, and project developers to test alternative development scenarios against a baseline and identify a preferred plan for a long term mix of land uses including energy facilities such as electric power plants and electric transmission lines. PLACE3S is unique because it quantifies the expected electricity and natural gas demand of each alternative land use scenario being considered, empowering the community to select energy efficient land use choices as they also plan for future generation and transmission needs. Soon PLACE3S will be able to characterize the cost effectiveness of a range of renewable and distributed generation options that best match the energy profile of each alternative development scenario for the area under study.

Coastal Power Plants

California's coastal communities have experienced significant population growth in recent decades. Several communities (*e.g.*, San Diego, El Segundo and Huntington Beach in Southern California, Morro Bay and Moss Landing on the Central Coast, and San Francisco on the San Francisco Bay) have existing operating power plants. These power plants were constructed in the 1950s and 1960s in areas designated for coastal-dependent industrial uses. Many of these facilities were initially isolated from the residential and commercial sectors of the community and allowed use of seawater for facility cooling purposes. However, subsequent population growth has surrounded the coastal-dependent industrial areas and its power plants.

As a consequence of population growth, many coastal communities have come to recognize their coastline as an important aesthetic, recreation and ecological and conservation area. The California coast has been recognized as an environmental resource worthy of state protection by such laws as the California Coastal Act. Projects to modernize or expand existing coastal power plants have triggered policy issues regarding the suitability of this type of industrial use and infrastructure being located on the coast, and triggered intense controversy and delays in Energy Commission siting proceedings.

Since 1996, the Energy Commission processed six power plant application requests involving power plants on the California coast or on the San Francisco Bay Estuary shoreline (Moss Landing, Morro Bay, El Segundo, and Huntington Beach on the coast, and Potrero and Contra Costa on the San Francisco Bay/Estuary). These applications involved a repowering, modernization or expansion of an existing facility. As of the end of 2002 the Energy Commission had licensed three of these six projects. The six projects have presented two major land use issues, summarized below.

Coastal/Bay Area Land Use Regulations

Coastal power plants require consideration of several issues in addition to those considered for non-coastal facilities, such as consistency with the California Coastal Act and City/County Local Coastal Plans, or consistency with the McAteer-Petris Act for a project within the San Francisco Bay Area. These Acts establish a comprehensive approach to govern land use planning along the California coast and the San Francisco Bay Shoreline. The Energy Commission is required to consult with the California Coastal Commission or the San Francisco Bay Conservation Development Commission for each power plant application within their respective jurisdiction, and receive a determination of consistency with their respective enabling legislation.

A major issue relating to consistency with coastal/shoreline land use regulations has been the need to examine alternatives to the existing facilities' cooling systems, which typically involve intake and discharge of ocean water. Cooling towers, which provide the primary alternative to once-through cooling, may result in additional noise, visual, or other concerns that must also be considered in terms of land-use compatibility with surrounding properties.

Siting Near Coastal Recreation Areas

The California coast provides an important resource in meeting the recreational needs of the state's growing population. Coastal recreational activities are a key land use concern for many communities. The recreational value of the coast and its beaches is based on many factors, including the coast's natural environment and scenic qualities.

Several operating power plants are located near beaches, parks and trails that receive large numbers of recreational users. While the existence of the power plants has not diminished the popularity of nearby recreational sites, local residents have sometimes argued that the quality of the recreational experience is diminished by the visual prominence of a power plant, temperature changes in the ocean water, noise, and traffic impacts among other issues. As a result, the impact of coastal power plants on recreational opportunities such as swimming, diving, surfing and other beach-related activities have become an issue of economic concern to coastal communities.

Socioeconomics

Summary of Findings

- Power plants reviewed by the Energy Commission since 1996 have generally been located closer to load (demand) than pre-1996 projects, and therefore closer to abundant local labor for construction and operation personnel. This has resulted in minimizing socioeconomic impacts on employment, housing, schools and public services.
- Starting January 2003, the Board of Equalization assesses all privately owned electric generation facilities 50 MW or larger, including facilities divested by the public utilities that had been assessed by counties after deregulation. These facilities will be assessed at fair market value, and revenues will be distributed to those jurisdictions located in the tax rate area where the power plant is located.
- The 17 power plants permitted by the Energy Commission since 1996 that were on-line by December 31, 2002 added 4,418 MW in generation capacity, and have resulted in approximately 3,900 peak construction jobs, 125 operations jobs, capital costs of approximately $1.5 billion, and, for fiscal year 2002-2003, approximately $23 million in property taxes.
- The ***2001 Environmental Performance Report*** estimated a 10-to-1 ratio of direct peak employment construction jobs to direct operation jobs for power plants. Data from the permitting of the non-emergency power plants approved by the Energy Commission since 1996 that were online by December 31, 2002, show this ratio was 25-to-1. This increase may be a result of faster construction cycles to meet the demands of the California energy crisis.
- Steam boiler plants typically have 40 to 50 maintenance and operation employees. Gas-fired peakers and combined cycle power plants, which are now being built, have a range from approximately 2 to 24 maintenance and operational workers.
- State law prevents public agencies such as the Energy Commission from imposing fees or other financial mitigation for impacts on school facilities. The school impact fee that can be levied by a school district usually ranges from $2,000 to $6,000 per power plant project. Municipal utility districts are exempt from these fees.

Importance of a Reliable and Affordable Electricity Supply

The biggest socioeconomic benefit of electric generation facilities comes from the electricity they provide. California has the largest economy of any state in the country and one of the largest economies in the world. Because electricity powers the economy and helps maintain the state's high standard of living, the availability of a reliable and affordable electricity supply is essential to the well being of the state and its citizens. Electric generating facilities supply electricity to California residences and businesses for a variety of uses, including lighting, heating, ventilation, and air conditioning, and power for industrial and agricultural motors. It is also essential to transportation, communications, public safety, and public health, as well as public comfort and convenience. In-state electric generation in particular enhances statewide electric supplies and system reliability by reducing the need for electricity imports over congested transmission lines.

California businesses and institutions consume approximately twice as much electricity as the state's residential users. In 2002, statewide electric consumption totaled approximately 270,000 GWh, including imports. **Table IV-3** shows the top ten counties for electric consumption and generation in the year 2000. Highly populated, urban counties in Southern California and the San Francisco Bay Area are the largest producers and consumers of electricity. Taking the physical size of counties into account, the City and County of San Francisco has the highest electricity use per square mile of any California county.

Table IV-3:
Top ten Counties in Electricity Consumption and Generation in 2000

Electricity Consumption	Electricity Consumption Per Square Mile	Per Capita Residential Electricity Consumption	Electricity Generation	Electricity Generation Per Square Mile
Los Angeles	San Francisco	Mono	Los Angeles	Contra Costa
Orange	Orange	Modoc	San Diego	Los Angeles
Santa Clara	Santa Clara	Tuolumne	Contra Costa	San Francisco
San Diego	Los Angeles	Alpine	San Bernardino	Ventura
San Bernardino	Alameda	Plumas	San Luis Obispo	Orange
Riverside	Sacramento	Calaveras	Kern	San Diego
Alameda	Contra Costa	El Dorado	Fresno	San Luis Obispo
Sacramento	San Mateo	Lake	Ventura	Sonoma
Kern	Yolo	Nevada	Shasta	Butte
Contra Costa	San Diego	Del Norte	Sonoma	Sacramento

Source: California Energy Commission, 2001. *Staff's Energy Demand 2002-2012 Forecast*. California Energy Commission, 2000. *Power Plants Online*. *California Statistical Abstract*, December 2001.

Small, rural counties consume the least amounts of electricity. They are, however, the largest electricity users on a per capita basis. The reasons for the high per capita electricity consumption in rural counties include:

- colder winters and hotter summers, since most of these counties are located in the foothills and mountains;
- higher use of electricity for space heating, water heating, and cooking, because many rural residents do not have natural gas service; and
- use of electricity to pump well water because many areas lack water districts to supply water.

Some of the top ten electricity-producing counties are on the list because of one or two very large thermal power plants. For example, San Luis Obispo County has both the Diablo Canyon and Morro Bay power plants. Similarly, Ventura County has Ormond Beach. Butte County, although small in size, is a top electricity producer per square mile because of its many hydroelectric facilities.

Outage Costs

In general, the power system is said to have adequate capacity if it has enough generation and transmission resources to meet the customer demand and maintain a reserve of capacity for contingencies. Building an electric generation and transmission system that would never have an outage would be prohibitively expensive. Instead, outages are minimized within a reasonable cost, with some added risk of outages (CEC 2002). The Energy Action Plan recently adopted by the Energy Commission, the California Public Utilities Commission, and the California Power Authority calls for maintaining a reserve margin of 15 to 18 percent (Energy Action Plan 2003). In addition, PG&E, under cost of service regulation, has recently stated they will pay $25 to $100 to residential customers without power for two to five days. SDG&E and Edison have performance-based rates that are linked to benchmarks such as outages (Liedtke 2003 and Said 2002).

How Market Forces Drive the Location of New Facilities

Before 1996, most large California thermal power plants were located near the coast because that was where the population was and the ocean was used for cooling purposes. Most of these facilities were built in the 1950s and 1960s. Three factors started to reverse this process. First, coastal land became more expensive and the California Coastal Commission imposed restrictions reflecting conservation and recreation needs. Second, starting in the 1970s there was a shift from steam generation to smaller, faster-to-construct, and more efficient and economic gas-fired simple-cycle and combined-cycle facilities. Finally, population growth shifted inland.

In the post-1996 deregulation era, several market factors drove and will continue to drive power plants to sites closer to load (demand). First, costs of transmission (*e.g.*, congestion, line losses, and upgrades borne by developers) are significant factors that affect competitive costs. To minimize these costs, power plants will locate close to load when possible. Second, opportunities for distributed generation utilizing combined heat and power exist next to essential facilities. In addition, increased concern over terrorism may help foster a decentralized system to minimize risks. These factors combine to encourage cost-effective power plants locating closer to load. Finally, demand-side management will have some, though currently uncertain, impact on the supply side in the future.

Property Taxation of Power Plants since 1996

A key local economic benefit of power generation facilities is the property tax revenue they provide. Some power plants are assessed for property tax purposes by the Board of Equalization (BOE) and others are assessed by the local county assessor. Municipally owned power plants located within the boundaries of the owning municipalities are exempt from property taxes. Power plants outside the boundaries of municipalities are taxable. Whether the BOE or the local county assesses the power plant affects the way the value of the power plant will be determined, and the allocation of the property tax revenue from the power plant to local government.

Property assessed by the BOE is revalued every year at its current fair market value. In contrast, property assessed by the local county assessor is subject to Proposition 13 value limitations, which generally means acquisition value with annual increases limited to no more than two percent. The basic tax rate applied to the assessed value of the property is essentially the same, one percent, though the exact rate may vary.

For public utility owned power plants assessed by the BOE, revenues are placed in a pool and shared with nearly all governmental agencies in a county according to a statutory formula. In contrast, property tax revenues from locally assessed property are distributed to only those governmental agencies in the tax rate area where the property is located, which is a grouping of properties within a county wherein each parcel is subject to the taxing powers of the same combination of agencies. .

When deregulation was enacted, the BOE assessed power plants that were owned by public utilities, while the local county assessed electric generation facilities owned by non-public utility owners such as cogeneration facilities. As a result of deregulation, the BOE adopted Property Tax Rule 905, transferring assessment jurisdiction of the 22 power plants divested by public utilities to the local county assessor on January 1, 1999. The Board retained the assessment of power plants still owned by the public utilities (primarily hydroelectric and nuclear facilities). Additionally, under this rule any privately owned power plant constructed in the future would be assessed by the local county assessor.

Under new legislation enacted in 2002 and a new rule adopted by BOE that year, beginning on January 1, 2003, any electric generation facility 50 MW or larger will be assessed by the BOE. The 22 facilities sold by public utilities and new facilities built since 1999 that meet the threshold level of 50 MW have now been returned to the BOE for assessment. These facilities will be annually assessed at current fair market value. Unlike other property assessed by the BOE, the property tax revenues from these power plants will not be placed in the revenue pool to be shared with all jurisdictions in the county. Instead, the revenues will be distributed only to those jurisdictions located in the tax rate area.

One might expect the annual fair market value of electrical generation facilities as assessed by the BOE to result in a value of electrical generation facilities higher or equal to their Proposition 13 value as assessed by counties. However, real estate values are somewhat subjective and opinions of value differ. Assessed values determined by the BOE may be higher, lower, or the same as values assessed by local county assessors (BOE 2002). **Table IV-4** summarizes the history of power plant assessments as to the assessment jurisdiction and allocation of property tax revenues.

Power Plant Construction and Operation Impacts

Impact of Energy Facilities on Property Values

Community members and land developers often express concern about proposed energy facilities such as power plants and transmission lines reducing their property values. Residents of rural areas often note that their land purchase prices were higher than their neighbors' because of a scenic view. They have stated that a proposed power plant or transmission line would ruin the view and overall scenic location, with a corresponding drop in property values. Similarly, developers of planned residential areas often express concern that their project would have little appeal and market value if an energy facility were built nearby. While considerable anecdotal evidence has been put forward for such an impact, there is little solid evidence indicating actual impact.

Energy facilities are often located in areas with multiple factors that can affect property values (such as degraded industrial views, waterfront views, nearby public recreation areas or freeways), which makes it very difficult to isolate the potential impact, if any, of the energy facility. Many areas can

Table IV-4: Power Plant Tax Assessment and Distribution in Calfirornia

Power Plant Category	**Before January 1, 1999** (Prior to Fiscal Year (FY) 1999-2000)		**From January 1,1999 to January 1, 2003** (FY 1999-2000 through FY 2002-03)		**After January 1, 2003** (starting FY 2003-04)	
	Assessment	Distribution	Assessment	Distribution	Assessment	Distribution
Power Plants Continuously Owned by Public Utilities (primarily Hydro and Nuclear)	BOE	Countywide	BOE	Countywide	BOE	Countywide
Power Plants Divested by Public Utilities	BOE	Countywide	County Assessor	Local Tax Rate Area	BOE	Local Tax Rate Area
Power Plants Constructed Post-Deregulation >50 MW	N/A	N/A	County Assessor	Local Tax Rate Area	BOE	Local Tax Rate Area
Power Plants Constructed Post-Deregulation <50 MW	N/A	N/A	County Assessor	Local Tax Rate Area	County Assessor	Local Tax Rate Area
Cogeneration Facilities and Qualifying Facilities	County Assessor	Local Tax Rate Area	County Assessor	Local Tax Rate Area	County Assessor	Local Tax Rate Area

become very attractive for residential development despite an industrial/energy facility presence. Two separate studies (Lindell and Earle, 1983; Clark and Nieves, 1994) found that when people were asked to rank the relative undesirability of a range of facilities and land uses, natural gas power plants were significantly more desirable (*i.e.*, had lesser impacts) than coal-fired and nuclear power plants, and refineries. This occurred even though the studies were based on older natural-gas-fired steam plants that have emission levels similar to existing coal-fired power plants (McCann 1999).

A recent study of property values related to wind farm developments was presented at WINDPOWER 2003, the annual conference and exhibition of the American Wind Energy Association. The study, conducted by the Renewable Energy Policy Project, was the first to systematically analyze property values to determine impacts to properties within view of the turbines. The study, which examined over 25,000 property transactions, found that wind projects do not harm viewshed property values (REPP 2003).

Estimated Socioeconomic Impacts for Selected Projects

The Commission permitted 34 power plants with a total generating capacity of 3,453 MW that filed applications prior to 1996 and that were operational in 2002. **Table IV-5** provides socioeconomic baseline information from the Application for Certification (AFCs) for thermal power plants permitted since 1996 that were online as of December 31, 2002. **Table IV-6** provides socioeconomic baseline information for thermal power plants licensed under the Commission's emergency permit process in 2001 that were online as of December 31, 2002.

In summary, for the 17 power plants listed in **Tables IV-5** and **IV-6**:

- 4,418 MW of electric generation were added;
- approximately 3,900 peak construction jobs were created;
- approximately 125 operating jobs were created;
- capital costs amounted to $1.4 to $1.6 billion for the 12 projects for which estimates were available;
- property taxes for non-emergency power plants were estimated to be $18.5 million to $20 million in fiscal 2002-2003, based on a combination of actual and estimated data; and
- property taxes for the emergency power plants are approximately $3.7 million in fiscal 2002-2003, based on actual data.

From 1996 to 2002, 37 new renewable projects, including biomass, digester gas, geothermal, landfill gas, small hydro, and waste tire facilities totaling 244.15 MW, were brought online. No socioeconomic information is available for these renewable energy projects, which were not under the Commission's permitting authority.

Table IV-5:
Socioeconomic baseline data for projts (except peakers) licesnsed by the Commission since 1996 and online as of December 31, 2002*

Project	Location and Owner	Capacity (MW)	Operating jobs	Const. jobs (peak)	Estimated Capital Cost**	Property Taxes Fiscal 2002-03 ***	Sales Taxes (est.) ****	Payroll	On-line Date
Sunrise Phase I	Fellows, Kern County. Edison, Mission Energy and Texaco Global Gas and Power	320	24	255	$174 million	$1.5 million (est.) Approximately $1.7 million (actual)	Construction: $217,000 to $362,500 Operation: $72,500-$87,000	Construction $18-23 million (1998 dollars) Operation $1 million/year	6/26/01
Sutter Power	Yuba City area, Sutter County Calpine Corp.	540	20	256	$135 million (materials and supplies)	$2.5 to $2.85 million (est.) Approx. $4.9 million (actual)	Construction: $6-$10 million	Construction $20 million Operation $1 million/year	7/2/01
Los Medanos Energy Center	Pittsburg, Contra Costa County Calpine Corp.	555	20	294	$360 million	$2 to $3 million (est.)	Information not available	Construction $26.4 million Operation $1.4 million/year	7/9/01
Delta Energy Center	Pittsburg, Contra Costa County Calpine Corp. and Bechtel	887	24	575	$572 million	$1.7 to $2.2 million (est.)	Construction: $700,000 to $1.4 million	Construction $36 million Operation $1.2 million/year	5/10/02
Henrietta Peaker Project	Henrietta Substation, Kings County GWF Energy, LLC	96	0 *****	93	$58.9 million (material and supplies)	$900,000 (est.)	Construction: $151,000	Construction $8.1 million Operation $184,000/year	7/1/02
Moss Landing (Units 1 and 2)	Moss Landing, Monterey County Duke Energy	1060	10	732	$400-$500 million	$4 million (est.) Approx. $5.1 million (actual)	Construction: $19 million	Construction $115 million Operation Not available	7/11/02
Huntington Beach Modernization Unit 3	Huntington Beach, Orange County AES	225	10	548	$130 Million	$1.2 million (est.)	Information not available	Construction $43 million Operation $1.5 million/year.	7/31/02
Valero Phase I	Bencia, Solano County Valero Refining Co.	51	3-4	150	$100 million	$1 million (est.)	Information not available	Construction $6 million Operation $50,000/year	10/18/02

* Information from Energy Commission permitting process (i.e., AFCs, testimony, etc.)

** Information as provided by the applicant in the AFC without a uniform methodology. Estimates may not be consistent.

***Actual data show tax filings there is an appeal process which may take several years. (Alrai 2003). Generally, power plants have estimated lives of 30 years. Sunrise Phase I, Sutter Power, Moss Landing Units 1&2, and Henrietta Peaker are 30 years; Los Medanos Energy Center, 25 years; Valero Phase I, 20 years; and Huntington Beach (Unit 3), 5 to 8 years.

**** Sunrise Phase I sales tax - Construction: $180,000 to $300,000 of total sales tax will be distributed to the county. Assuming 39 percent of payroll is spent on taxable goods, the construction workforce will generate $254,000 to $333,000 in sales tax. Operation: $31,000 per year from payroll. Sutter Power sales tax - Construction: Local Sutter County sales tax would be $12,500 to the County, $300,000 to the State of California, and $50,000 to the City for a total of $362,500. Moss Landing sales tax – Of total, $2 million to Monterey Co., $17 million to the state. Henrietta Peaker sales tax – Of total, $26,000 to Kings Co., $125,000 to the state.

***** Power plant is remotely operated and uses personnel from adjacent plants for maintenance.

Table IV-6: Socioeconomic Baseline Data for Emergency Peaker Projectslicesnsed by the Commission in 2001 and Online as of December 31, 2002*

Project	Location and Owner	Capacity (MW)	Operating Jobs	Const Jobs (peak)	Est. Capital Cost **	Actual Property Taxes Fiscal 2002-2003	On-line Date
Wildflower Larkspur	San Diego, San Diego County. Wildflower Energy, LLP.	90	0***	200	$90 Million	Approx. $1 Million.	7/16/01
Wildflower Indigo (Units, 1,2, and 3)	Palm Springs, Riverside County. Wildflower Energy, LLP.	135	0***	200	$75 million	Approx. $1 million.	7/26/01 and 9/10/01
Alliance Drews	Colton, San Bernadino County. Alliance Colton, LLC.	40	0***	20	Unknown	Approx. $374,000	8/15/01
GWF Hanford	Hanford, Kings County. GWF Power Systems.	95	0***	89	Unknown	Approx. $674,000	9/01/01
Alliance Century	Colton, San Bernadino County. Alliance Colton, LLC.	40	0***	20	Unknown	Approx. $374,000	9/15/01
Calpeak Escondido (Enterprise)	Escondido, San Diego County. CalPeak Power, LLC.	49.5	0***	80	$35 million	Approx. $75,000	9/30/01
Calpeak Border, LLC Phase I	Otay Mesa, San Diego County. CalPeak Power, LLC.	49.5	0***	80	$45 million	Approx. $76,000	10/26/01
Calpine Gilroy (Units 1, 2, and 3)	Gilroy, Santa Clara County. Calpine Corp.	135	0***	200+	$80 million	Unknown.	12/14/01
Calpine King City	King City, Monterey County. Calpine Corp.	50	0***	150	$35 million	Approx. $90,000	1/14/02

* Five peaker projects with DWR contracts totaling about 245 MWs slated to be online in 2001 and 2002 are included in the biology section but not included in Table IV-5. Because these projects were not licensed by the Energy Commission, the Commission has no socioeconomic data on these projects. The projects are Wellhead Power (2 units) and Calpeak Power (3 units). There are other projects included in the biology section list that are not reflected in Tables IV-5 or IV-6. This information is from the Energy Commission's 21-day permitting process.

** Information as provided by the applicant in the AFC without uniform methodology. Hence, the information may not be accurate.

*** Power plant is remotely operated and uses personnel from adjacent plants for maintenance.

Direct Construction and Operation Impacts

The ***2001 Environmental Performance Report*** observed that for selected California power plants, direct jobs during plant construction outweigh direct jobs in power plant operations (CEC 2001). A combined-cycle power plant was estimated to employ approximately 250 workers at the peak of its two-year construction schedule. The average number of permanent operator jobs at these plants was projected to be 25, resulting in a 10-to-1 ratio of direct peak construction jobs to direct operation jobs. Power plants are usually estimated to have a projected life of 30 years, but this depends on economic conditions. Information from **Table IV-5** for non-emergency projects shows a 25-to-1 ratio. This difference may result from faster construction cycles (*e.g.* using more personnel) in order to meet the demands of the California energy crisis. In terms of overall employment in the electric section, in 1990 statewide power plant operator positions were estimated at 5,350 and are projected to be 6,350 in 2005, an increase of 19 percent (California Employment Development Department 2002).

Secondary Employment and Income Impacts

To better appreciate the economic benefits of a power plant, secondary impacts (indirect and induced impacts) need to be included. Three types of impacts result from an increase in demand from an industry: 1) direct impacts, which are the changes in economic activity during the first round of spending, *i.e.*, construction wages; 2) indirect impacts, which are the changes in sales, income, or employment within the region for companies supplying goods and services; and 3) induced impacts, which are the changes in an economic system (income and employment) at the local, regional, or national levels caused by changes in spending patterns due to direct and indirect effects (Moss *et al.* 1994).

Multipliers are used to show the direct, indirect and induced employment and income impacts. For example, for the La Paloma project, which went online January 2003, the applicant used an Impact Analysis for Planning (IMPLAN) model construction multiplier of 3.23 in the AFC. This means that an average direct impact for construction and contract staff (power plant plus transmission lines and water pipelines) of 451 equates to 1,006 secondary jobs in Kern County. For operations there are 35 direct jobs and an IMPLAN multiplier of 2.88 was used, resulting in an estimate of 66 secondary jobs. This economic impact analysis was found acceptable because IMPLAN multipliers are a product of a widely accepted input-output model. Secondly, the multipliers are within an acceptable range of 2 to 2.5 over the long run often cited by many economists (Moss *et al.* 1994).

This example of economic impacts, and the socioeconomic analysis done in the siting certification program, only looks at gross economic impacts. However, the applicant's results show only the impact of a single project (sum of direct, indirect, and induced impacts) on the local and regional economy. Professionals in the field of economic impact analysis have stated that one of the most common errors in economic benefits analysis is the failure to apply a "with" and "without" analysis and to consider alternatives (Schmid 1989; Marbek 1993). Comparison of alternative investment impacts leads to two other employment impacts, referred to as "displacement" and "respending" impacts (Marbek 1993). A comparative investment analysis includes respending impacts (impacts that result from cost savings to the economy that arise from cost-effective investments) that yield total impacts, minus the displacement impacts (difference between jobs created and jobs displaced), which yields net economic impact. An alternative to the proposed project will also have spending and employment impacts. The net spending and employment benefits of the proposed project would be any increment above the alternative project.

Mitigation for Educational Impacts

Under state law, public agencies such as the Energy Commission may not impose fees or change financial requirements to offset the cost for school facilities. However, a school impact fee is levied by a school district according to Section 65996 of the California Government Code on building square footage, which typically results in a fee of $2,000 to $6,000 for projects permitted by the Energy Commission. Municipal utilities are exempt from school impact fees.

Socioeconomic Trends for Selected Power Plants

Appendix IV-2 provides an assortment of socioeconomic data for the 28 largest power plants in California. In the ***2001 Environmental Performance Report***, staff provided this information for 13 power plant projects. This year's project list includes some but not all of the 13 projects previously documented. The data provided includes city and/or county population totals, racial percentages, median family incomes and housing occupancy for each decennial census, 1950 through 2000.

Trends in the Post Deregulation Era

Reduced Operation Workforce

Prior to deregulation, expenses such as operation and maintenance that accompanied capital investments were typically included in a utility's rate base. This work often was done in-house by utilities. In the post-deregulation era, merchant plants are more competitive, and contracting out operation and maintenance expenses are part of cost-effective operation.

Steam boiler plants have typically required 40 to 50 maintenance and operation employees. Gas-fired peaker and combined-cycle power plants only need approximately 2 to 24 operations and maintenance workers (see **Tables IV-5** and **IV-6**). For such plants the smaller plant components can be sent to the factory to be repaired and a replacement brought in, and hired contractors can repair larger plant components at the site. Some plants are remotely operated and use personnel from nearby plants for maintenance. The number of power plant operators in California was estimated to be 5,350 in 1990, and is projected to rise to 6,350 in 2005, which represents a projected growth of 19 percent (California Employment Development Department 2002).

The Energy Commission (Energy Commission 2003) has estimated the number of maintenance and operational employees for other technologies as follows:

- Solar photovoltaics, six at 50 MWs (net capacity).
- Solar parabolic without thermally enhanced storage or gas, 21 at 100 MWs (net capacity).
- Solar parabolic with gas only, 21 at 100 MWs (net capacity).
- Solar parabolic with thermally-enhanced storage only, 21 at 100 MWs (net capacity).
- Solar thermal-sterling dish, 12 at 30 MWs (net capacity).

Facility Location Trends since Deregulation

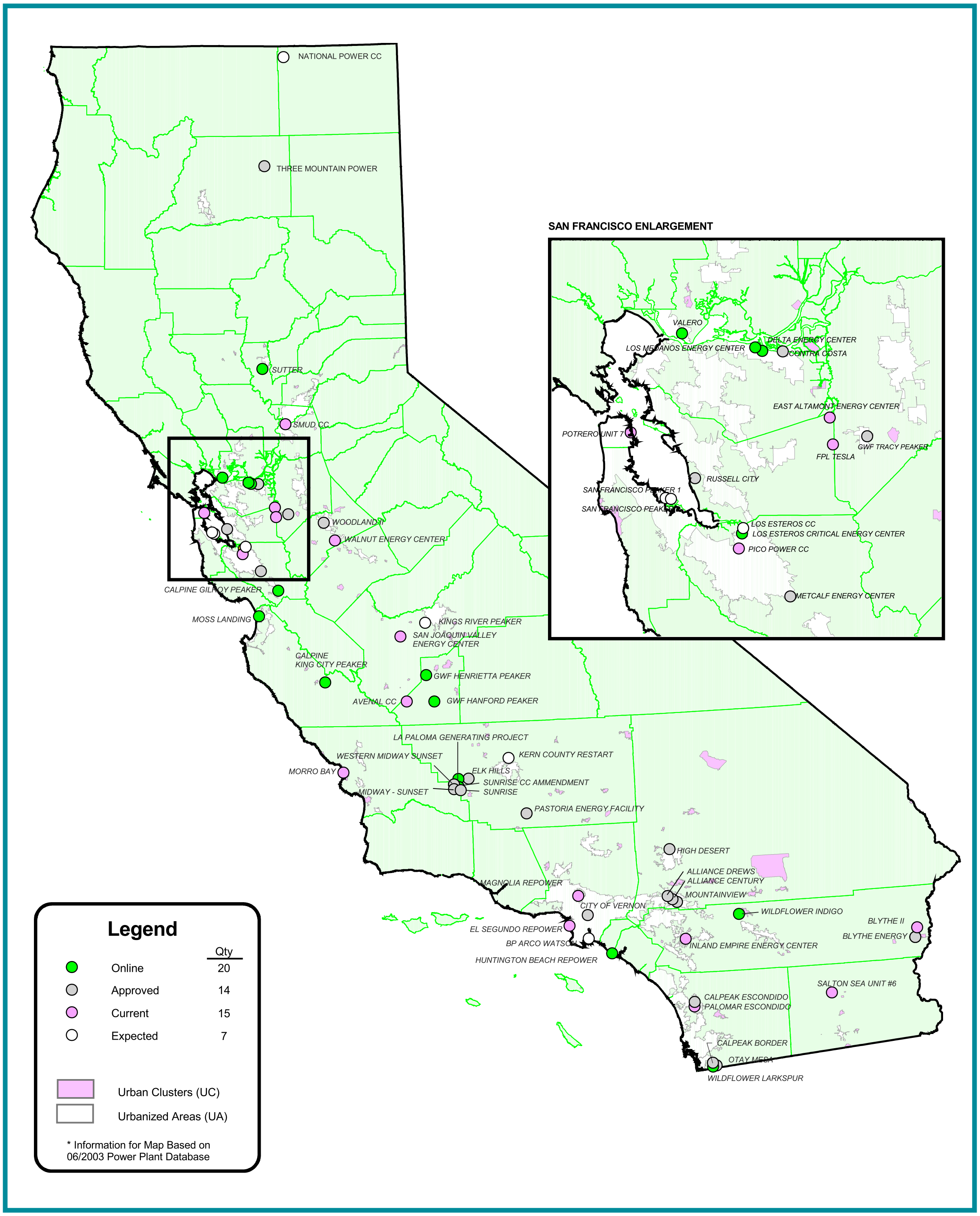
Figure IV-1 shows the location of all power plant projects that fall under Energy Commission permitting jurisdiction (*i.e.*, thermal power plants 50 MW or larger) that were approved by the Commission from 1996 through 2002. The figure also includes projects with applications currently in review or expected to be filed with the Energy Commission. The figure also shows the proximity of these projects to densely populated or urbanized areas. Urbanized Areas are densely settled areas that have a census population of at least 50,000, as opposed to an Urbanized Cluster, which has a census population of 2,500 to 49,999. **Figure IV-1** demonstrates that very few of the 56 power projects (online, approved, current, or expected) are outside of a reasonable distance from an Urbanized Cluster. But in those cases where power plants were some distance from load, socioeconomic impacts from using non-local labor for the construction and operation of a power plant project have been minimal.

Table IV-7 lists the minority and low-income population percentages within a six-mile radius of the 17 power plant projects described in **Tables IV-5 and IV-6** above. Because some of these projects were approved prior to release of Census 2000 data, the percentages shown are estimates that were used during the permit process, based on Census 1990 data.

Table IV-7:
Demographic Data for Projects Licensed by the Commission After 1996 and Online as of December 31, 2002

Project	Percent Minority	Percent Low-Income
California total, 2000 Census	**53%**	**13%**
California total, 1990 Census	**43%**	**13%**
Sunrise Phase I	43%	31%
Sutter Power	29%	18%
Los Medanos Energy Center	44%	12%
Delta Energy Center	33%	10%
Henrietta Peaker Project	51%	20%
Moss Landing (Units 1 and 2)	59%	12%
Huntington Beach Modernization Unit 3	14%	6%
Valero Phase I	54%	8%
Wildflower Larkspur	72%	5%
Wildflower Indigo (Units, 1,2, and 3)	41%	14%
Alliance Drews	65%	16%
GWF Hanford	46%	25%
Alliance Century	63%	17%
Calpeak Escondido (Enterprise)	39%	11%
Calpeak Border, LLC Phase I	72%	5%
Calpine Gilroy (Units 1, 2, and 3)	58%	13%
Calpine King City	76%	11%

Figure IV-1:
All CEC Project Greater than or Equal to
50 MW 1996-2002



Conclusion

The most notable socioeconomic developments in the last few years are that:

- the number of peak construction workers for recent power plants has approximately doubled compared to previous years, which may be due to condensed construction periods to bring power plants on line quicker; and
- effective January 1, 2003, the State Board of Equalization began assessing 22 large power plants that had been sold to independent power producers, in place of county assessors. All new independent power plants 50 MW or larger will also be assessed by the Board of Equalization.

Environmental Justice

Summary of Findings

- The Energy Commission and California Department of Transportation were the first state agencies to include environmental justice concerns and demographic information in their environmental impact analyses.
- The Commission's approach to environmental justice emphasizes local mitigation and seeks to reduce environmental impacts that could affect local populations to less than significant levels. Of the projects identified as having greater than fifty-percent minority populations within a six-mile radius, appropriate mitigation has been identified to reduce significant impacts to less than significant levels, thereby removing the potential for an environmental justice issue (disproportionately high and adverse impact associated with a proposed project). Therefore, the Commission has never considered denial of a project based on the findings of an environmental justice analysis.
- From 1979 through 1995, 14.3 percent of power plant applications submitted to the Commission were sited in communities where minorities comprised greater than 50 percent of the population.
- From 1996 through 2002, 50 percent of power plant applications submitted to the Commission were sited in communities where minorities comprised greater than 50 percent of the population.
- As of Census 2000, minorities (several ethnic groups who are other than non-Hispanic white) comprise the majority of the population in the state, so environmental justice will likely be a consideration in most future power plant siting cases.
- Power plants proposed in densely-populated urban areas are often sited where residential land uses encroach on older industrial areas.
- Community involvement related to environmental justice during siting cases has primarily occurred in proposed power plant cases in the large urban areas of Los Angeles and San Francisco.

What Is Environmental Justice?

Environmental justice as defined by SB 115 (1999, Solis) is "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation and enforcement of environmental laws and policies." Environmental justice has its roots in the civil rights movement of the 1960s. It gained momentum in the mid-1980s as an activist and community response to a growing concern that minority and low-income populations bear a disproportionate share of society's environmental risks in the siting, construction, and operation of toxic facilities and other locally unwanted land uses.

Environmental justice concerns typically arise from the minority and low-income communities located near major industrial areas that may include power plants, hazardous waste generators, waste water treatment plants, refineries, and sites contaminated with toxic materials. When neighborhood activists and citizens believe their community is disproportionately impacted by heavy industrial uses and polluting facilities, they contend that to license a power plant in their neighborhood would add another source of air pollutants to an already overburdened community, the effect being worsening air quality, water quality, and public health.

Power plants are often sited in existing industrial areas near the electricity users to reduce the need for new transmission lines. In large urban areas, where the electricity demand is greatest, communities near the industrial uses are exposed to higher than average pollution levels from a variety of sources. Thus, such communities can be expected to be concerned about the siting of a state-of-the-art, gas-fired power plant, even though it has lower emissions than a coal or oil burning plant.

This section provides an overview of the Commission's approach to environmental justice, and a look at the issues and concerns surrounding the siting of power plants in a state where demographics have changed significantly from the 1990 census to the 2000 census.

The President's Council on Environmental Quality has issued guidance on how to conduct an environmental justice analysis (CEQ, 1997). The Council defines minority as individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black not of Hispanic origin; or Hispanic. Low-income populations are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P-60 on Income and Poverty. The poverty threshold in 2002 for a family of four (two adults and two related children under 18) was $18,244. Many experts have argued that family income needs should be assessed using local standards and the poverty threshold should be measured relative to median family income in the region. For example, if poverty were measured using half the California median family income, the poverty threshold for a family of four in 2000 would have been $26,347.

In 1998, the EPA's Office of Environmental Justice issued guidance for incorporating environmental justice concerns in EPA's National Environmental Policy Act compliance analyses (US EPA 1998). The guidance states that an environmental justice analysis includes three important elements: 1) identify the presence of low-income and minority populations, 2) determine if there are disproportionately high and adverse impacts on those populations, and 3) provide the public with the opportunity for meaningful participation.

Environmental Justice in California

Starting in 1999, a series of laws have been enacted to implement environmental justice in state programs and agencies. These laws have included the following provisions:

- establishing the Office of Planning and Research as the coordinating agency for state environmental justice programs;
- directing the California Environmental Protection Agency to develop an interagency environmental justice strategy;
- requiring the Office of Planning and Research to incorporate environmental justice considerations in general plan guidelines;
- directing air districts with more than one million residents to expend specified emission reduction funds in communities with the most significant exposure to air contaminants and communities of minority and/or low-income populations, and encouraging districts with less than one million residents to do the same;
- requiring the Integrated Waste Management Board to provide environmental justice models (by April 1, 2003) and information to local jurisdictions for siting landfills; and

- establishing an Environmental Justice Small Grant Program admistered by the California Environmental Protection Agency.

The legislative response was due, in part, to concerns regarding the environmental health of communities, and as a statewide effort to incorporate the principles of environmental justice with the programs, policies, and activities of the California Environmental Protection Agency and its boards, departments, and offices. To date, Governor Gray Davis has signed nine bills that promote the advancement of environmental justice goals in California, and other environmental justice bills currently are under consideration in the legislature.

Environmental Justice at the Energy Commission

In 1994, environmental justice was brought to the attention of Commission staff by the Bayview Hunter's Point Community in response to the proposed siting of San Francisco Energy Company's Cogeneration Project. Environmental justice became a major policy issue in the case and the focus of possible litigation. Although the project was approved by the Commission, environmental justice advocates and members of the community opposed to the development of the project directly contributed to the inability of the project to secure a lease for the project site from the City and County of San Francisco. Without the lease, the project was not developed.

After this case, Commission staff began conducting environmental justice analyses on all subsequent energy facility siting cases. As such, the Commission was one of two state agencies at the time that incorporated the precepts of the federal guidelines into their environmental impact analysis. The Commission's siting process has been designated as a functionally equivalent process under CEQA, and it incorporates a significant level of opportunity for public input, including public workshops, documents for public review and comment, and a variety of committee hearings that the public is encouraged to attend. In addition, the Commission is one of only two California state agencies that have an appointed position, the Public Adviser, whose sole purpose is to assist the public to participate in Commission proceedings to the extent they desire. The Public Adviser's Office conducts outreach to local community groups and provides translations, when appropriate, of public meeting notices and some project information to community members. The Commission's Media and Communications Office also sends information about proposed projects and the Commission's siting process to all project area media with a request that they help get the word out about the proposed project.

The criteria Commission staff use in their environmental justice analysis is based on EPA's guidance document on environmental justice (US EPA 1998). The Commission's environmental justice analysis is composed of three primary steps: demographic screening, public outreach, and impact assessment. Under current procedures, when an Application for Certification is deemed adequate, Commission staff conducts a demographic screening analysis. The purpose of the screening analysis is to determine the demographics of the project area at the census block level. Census blocks do not correspond to city blocks (they may include four or more city blocks) and are the smallest unit of census geography for which decennial census data is tabulated. Staff then uses the demographic maps to determine whether there exists a low-income or minority population[1] that meets one or more of the following criteria:

- the minority or low-income population of the affected area is greater than fifty percent of the affected area's general population;
- the minority or low-income population of a pocket or cluster (one or more census blocks) within the affected area is greater than 50 percent; or
- the minority population percentage of the area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Commission staff uses a six-mile radius around the proposed site as the area of potential impact, based on the parameters for air quality dispersion modeling used in staff's analysis. In one case to date, the Elk Hills project, staff evaluated the potential impacts on a small minority community within one quarter-mile of a proposed electric transmission line. Staff conducts demographic screening analyses for transmission line expansions when they are proposed as part of power plant siting project.

When a minority or low-income population is identified through the screening analysis, staff in the technical areas of air quality, public health, hazardous materials, noise, soil and water resources, waste management, traffic and transportation, visual resources, land use, socioeconomics, and transmission line safety and nuisance consider possible impacts on the minority/low-income population as part of their analysis. This analysis consists of identification of significant impacts (if any), identification of mitigation, and determination of whether there is a disproportionate impact on a minority or low-income population if an unmitigated significant impact has been identified.

Staff's environmental justice approach includes providing notice (in appropriate languages, when possible) of the proposed project and opportunities for participation in public workshops to minority and low-income communities, and providing information on staff's environmental justice approach to minority and low-income persons who attend staff's public workshops.

Since 1996, of the 52 siting cases (including emergency projects) filed with the Commission, 26 projects have been identified as having potential environmental justice issues because of minority or low-income populations within a six-mile radius of the proposed projects. It is important to note that the presence of an environmental justice population does not equate to an environmental justice issue nor does it require the Commission or any regulatory agency to deny a project.

Of the projects having potential environmental justice issues, two have been the subject of complaints with the EPA. In 1999, intervenors in the Los Medanos (98-AFC-1, certified on August 17, 1999) and Delta (98-AFC-3, certified on February 9, 2000) siting cases filed a complaint with the EPA Office of Civil Rights against the Commission, the Bay Area Air Quality Management District, and the California Air Resources Board for violations of Title VI of the federal Civil Rights Act. The complainants stated that the projects, both located in the City of Pittsburg, would further inflict disparate impacts from criteria pollutants on low-income and minority populations in Contra Costa County. The Title VI complaint was the subject of arbitration in 2002 and earlier this year.

[1] The term "minority" is not a numerical reference because, as of the 2000 Census, no racial or ethnic group constituted a majority in California.

The arbitration ended amicably among all the parties, but without a settlement of the complaint. The Commission has not yet received a summary of the meetings and how they concluded from the arbitrator.

Staff seeks appropriate mitigation to reduce significant impacts to less than significant in all cases, whether an environmental justice population is present or not. Of the projects identified as having greater than fifty-percent minority populations within a six-mile radius, the Commission has reduced all significant impacts to less than significant levels through appropriate mitigation, thereby removing the potential for an environmental justice issue (high and adverse disproportionate impact associated with a proposed project). Therefore, the Commission has never considered denial of a project based on the findings of an environmental justice analysis.

Community Response to Environmental Justice at the Energy Commission

In some communities where power plants are being proposed, local response to the issue of environmental justice has been strong, with some citizens, activist organizations, and local agencies taking an intervenor role in the siting process on behalf of environmental justice issues in their communities. Environmental justice community response to projects does not vary as a function of the type of power plant, *e.g.* smaller simple-cycle peaker projects versus larger combined-cycle units, but is more a function of community demographics, existing air quality conditions, and existing industrial concentrations.

Community response has been strongest in the Nueva Azalea (00-AFC-3), Potrero Repower (00-AFC-4), and the Baldwin Hills (01-EP-11) projects. The Nueva Azalea application was withdrawn following a local community vote expressing opposition to the project. The Baldwin Hills application for an emergency permit faced strong local opposition with approximately 1,000 and 3,000 local residents attending the two public meetings opposing the project. That application was withdrawn after the project was unable to obtain a variance from the South Coast Air Quality Management District that would have been necessary for the project to meet the on-line deadline set for the emergency projects. Environmental justice was also raised as an issue, very late in the Commission's siting process, by representatives of a small minority community near the Blythe I (99-AFC-8) project. To date, intervenors and citizen activists have represented both Bay Area and Southern California communities in the siting process.

Commission staff has recommended environmental impact mitigation that would reduce adverse public health or safety impacts to less than significant in every power plant siting case to date. In some cases community groups, environmental justice advocates, and in one case a local government agency have expressed the opinion that the Commission had not done an adequate environmental justice analysis, largely because they believed staff had not adequately considered the existing pollution impact on their community. Staff has also heard from such groups that the screening analysis is deficient because it does not recognize schools as pockets of minority population, that decision-makers have already decided in favor of the applicant, that the Commission has not provided a legitimate forum where community concerns and community participation are considered part of the Commission's decision-making process In short, many environmental justice advocates do not think the Commission's licensing process provides an equal opportunity to influence government decision-makers, even though the Commission's process is significantly more open, transparent and proactive in its encouragement to the public to participate in the process than any other California public agency permitting process.

Demographic Changes in California

The 2000 Census was the first census enumeration where multiracial Americans were allowed to identify with multiple groups on the question of race. Census 2000 was also the first US decennial survey in which the majority of California's population (53.3 percent) identified as non-white or Hispanic. According to Census 2000, non-Hispanic whites, although still the largest racial or ethnic group, are no longer the numerical majority in the state. The recent census confirms California's trend of increasing ethnic and racial diversity since World War II. The Department of Finance expects these trends to continue and predicts that by 2025, Hispanics will be the largest population group in the state.

Historically, growth areas in the state have been in the urban coastal regions of the San Francisco Bay Area and Los Angeles County. However, demographic data from the 2000 census show that the highest growth rates in the state during the last decade were in the Central Valley, and in Orange, Riverside, San Bernardino and San Diego Counties in Southern California. California's rapid population growth, racial and ethnic change, and regional population shifts indicate demographic trends that have implications for environmental justice in future siting cases.

Review of Siting Project Demographics

Of the 52 projects (including emergency peaker projects) filed with the Commission since 1996, 26 have been sited in communities where minority populations within the project's six-mile radius exceed the greater than 50 percent threshold. (These data are presented in **Appendix IV-3**.) It is important to note that power plants are often sited in industrial areas where residential or encroaching residential uses also are situated. Environmental justice communities often have raised the issue of incompatible land use and zoning when a power plant is sited in proximity to residences, schools, day care centers, and other sensitive land uses.

As shown in the 2000 census, California is a state where minorities now comprise the majority in population. Given the state's racial and ethnic diversity, it is likely that many power plants will be proposed in areas with large minority populations. Currently, the deregulated electricity generating industry makes decisions regarding the geographic location of proposed power plants. A number of factors influence the industry's location decisions, such as the proximity of transmission lines, availability of industrial land, water availability, emission reduction credits, and other infrastructure necessary to construct and operate power plants.

Trends in Community Involvement in Environmental Justice

In California, as well as other states, community activism in environmental justice is a growing component of regulatory land use decisions. From 1994 through the beginning of 1998 when deregulation took effect, the Commission licensed one power plant, San Francisco Energy Company, and encountered environmental justice concerns and intervention during that energy facility siting case. Since 1998, the number of applications for certification received by the Commission has increased substantially, but community involvement related to environmental justice has primarily occurred in the Los Angeles and San Francisco areas. Community involvement in environmental justice is due to many factors, some of which include historical patterns of incompatible land uses, communities' concerns regarding disparate enforcement of environmental laws, a growing state-wide racial and ethnic diversity, regional population shifts in the state, and increased opportunities to address local concerns.

Environmental justice communities often lack funds to hire attorneys and expert witnesses in the technical areas analyzed by the Commission in the power plant certification process. Organizations like the Golden Gate University School of Law's Environmental Law and Justice Clinic, the Lawyer's Committee for Civil Rights, Communities for a Better Environment, and Greenaction provide some legal and resource assistance to communities seeking a voice at hearings and workshops, and to those who file for intervenor status.

The state's growing population, particularly with respect to ethnic and racial diversity and increased community activism in environmental justice, makes it essential that the Commission's environmental justice approach continue to be responsive to community concerns. This is particularly important in the areas of community participation, cumulative risk assessment, mitigation of significant adverse impacts, and the assessment of disproportionate impact.

June 2003

Environmental Performance Report
Chapter 5
Conclusions

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

Chapter 5
Conclusions

The ***2001 Environmental Performance Report*** concluded that the collective impacts of power plant facilities have declined over time due to improvements in thermal efficiency, fuel switching from oil to natural gas, emission control technology advances, the development of renewable generation resources, and the adoption of environmental laws and regulations. While the trend in improved environmental efficiency – fewer environmental impacts per unit of energy produced – was positive, significant concerns with impacts to aquatic resources from hydropower generation and once-through cooling continued.

This ***2003 Environmental Performance Report*** shows that this trend toward improved environmental performance of the electric generating system has continued since deregulation was enacted into law in 1996. Despite the energy crisis of 2000 and 2001, which has had major financial impact on all aspects of the energy market in California, the general trend toward improved environmental performance does not appear to have been significantly affected for good or ill by the deregulation of the system. This appears primarily to result from the fact that the basic laws and regulations that serve to protect the environment and public health were not changed by market deregulation and the utilities' divestiture of their major generation assets. With these protections in place and technological advances in efficient generating capacity and environmental controls, the addition of new generating capacity over the coming decade will serve to further improve the environmental performance of the system as a whole.

While general trends are positive, significant regional, generation sector and environmental media differences in energy system impacts remain. Decreases in air emissions from the electricity generation sector are impressive and can be attributed to successful applications of Clean Air Act regulations by the Air Resources Board and local air quality management districts. Air quality levels continue to be poor throughout the state, and the relative contributions of power plant emissions to local air basin inventories and air quality varies regionally.

More complex are the tradeoffs between impacts to air, water and land. Impacts to aquatic ecosystems continue to be the most difficult to understand scientifically, and the most difficult to alleviate. For example, hydropower does not contribute to air quality impacts, but aquatic ecosystems at a watershed scale have been severely degraded by hydropower development and operation. Repowering a large natural gas-fired power plant at one of California's 21 coastal energy complexes means that new generation units with high thermal efficiency and very low emissions can be installed. Existing infrastructure can also be re-used, which minimizes new impacts to terrestrial habitats from new foundations, roads and transmission lines. But the tradeoff can be continuing impacts to sensitive estuaries, bays and marine areas.

Wind energy is a resource of promise that will be expanded in California due to the Renewables Portfolio Standard. It is "clean" in that it emits nothing to the air, yet continuing impacts to hawks and eagles remain an issue of concern. Electric transmission lines enable the effective transfer of electricity from areas of generation to areas of demand, which means that a wide array of energy resources can be brought to large urban areas from distant parts of the state and western North

America. But the full environmental effect of transmission lines on birds, desert ecosystems and forested regions has yet to be documented, and is an issue of concern.

Differences in regulatory systems contribute to these varying impacts to differing parts of the natural environment. Poor air quality impacts human health, so air emissions are closely monitored, well understood, and tightly regulated by an interlocking system of federal, state and local authorities. The impacts to water quality and aquatic ecology from power plants of all types typically tend not to directly affect human health. This may be why impacts to river fisheries and coastal bays are more difficult to regulate and mitigate. The regulatory system for water quality and aquatic species is fragmented across multiple laws (Clean Water Act, Porter-Cologne, Federal Power Act, California Fish and Game Code, Warren Alquist and California Coastal Act, for example) and multiple state and federal jurisdictions. Differing agencies have differing priorities and statutory mandates.

Energy imported from outside of California's borders means less impact to California's natural resources and positive effects for the economies of other states and countries. California utilities own more than 6,200 MW throughout the west, primarily coal-fired generation. Coal is a low cost and reliable energy resource, but emits higher levels of NOx, particulate matter and SOx than in-state natural gas-fired generation. Air quality in neighboring states tends to be better, so the net impact to air quality is less than if the plants were located in California. This scenario does not hold for Mexico. Poor air quality in the border region of Mexico raises issues of varying international regulatory standards, especially for power plants built to serve California energy markets.

Such examples of tradeoffs between regions, between impacts to air versus land versus water, or between impacts to a Southern California air basin compared to a Northern California watershed, are extremely difficult to assess given current structures of governance and regulation. The Energy Commission cannot yet report on cumulative energy effects, nor assess the relative contributions of electricity generation and transmission, to different air basins, watersheds and bioregions. Two root causes are a lack of systematic environmental monitoring data and compilation across all statutes related to the energy sector, and the lack of a scientific method to assess the variation in environmental effects across technology sectors and environmental media. As reported in this ***2003 Environmental Performance Report***, lack of current, sufficient scientific environmental data hampers the Energy Commission's ability to fulfill its statutory responsibility to report to the Legislature, Governor and public on the environmental performance of all aspects of California's electricity generation and transmission system. Life cycle impact analytic methods may offer promise to better understand the full systems-level effects of the state's energy generation and transmission system. Such methods require large amounts of environmental data however, and are complex when an energy system as vast as California's is analyzed.

One important environmental issue facing California is not addressed in the ***2003 Environmental Performance Report***. Global climate change will create a series of effects on California climate and hydrology that will in turn impact the state's wide array of bioregions and ecosystems. Many of the state's habitats and ecosystems are small and already stressed. The scale of climate change effects will be pervasive, and may alter ecological balances in specific ecosystems and bioregions. Specific electricity generation and transmission effects on local environmental systems may in turn become more acute. Electricity generation contributes to climate change, and will be affected by it as well. While this may be the single greatest environmental issue before the state, analysis of these climate change issues was beyond the scope of this report.

In sum, the Energy Commission staff believes, based on the available data, that the general environmental performance trend is positive. The environmental footprint of the energy system required to supply the state's people and economy is relatively small compared to that for other parts of the nation and the world. Discrepancies in impacts to various parts of the natural environment remain large though. The Energy Commission has direct jurisdiction over a relatively small portion of the state's electrical generation system. As cooperative relationships are formed with other state and federal agencies and a more robust collective understanding of the state's energy system emerges, the Energy Commission will be able to more capably report on the complete extent of the environmental performance of California's electrical generation and transmission systems.

Environmental Performance Report
References, Acronyms and Glossary

ENVIRONMENTAL
PERFORMANCE REPORT
JUNE 2003

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Glossary

Anadromous — Ocean-going; aquatic organisms normally living in saltwater (sea water) that ascend rivers in search of freshwater for spawning.

Attainment —Measured levels of an air pollutant compared to national and local ambient air quality standards.

Biomass — Energy resources derived from organic matter. These resources include wood, agricultural waste, and other living-cell material that produce heat energy through direct combustion, gasification or fermentation processes. They also include algae, sewage, and other organic substances that may be used to make energy through chemical processes.

Boiler — A closed vessel in which water is converted to steam.

Bottoming cycle — A means to increase the thermal efficiency of a steam electric generating system by converting some waste heat from the condenser into electricity rather than discharging all of it into the environment.

British Thermal Unit (Btu) — The standard measure of heat energy. It takes one Btu to raise the temperature of one pound of water by one degree Fahrenheit at sea level.

California Endangered Species Act — The State law, originally enacted in 1970, expresses the State's concern over California's threatened wildlife, defined rare and endangered wildlife and gave authority to the Department of Fish and Game to "identify, conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat in California…" The statute is under the State Fish and Game Code as Chapter 1.5.

California Environmental Quality Act — Enacted in 1970 and amended through 1983, CEQA established state policy to maintain a high-quality environment in California and set up regulations to inhibit degradation of the environment.

Capacity — The maximum amount of electricity that a generating unit, power plant or generating facility can produce under specified conditions. Capacity is measured in megawatts and is also referred to as the Nameplate Rating.

Capacity Factor (cf) — A percentage that tells how much of a power plant's capacity is used over time. For example, typical plant capacity factors range as high as 80 percent for geothermal and 70 percent for cogeneration.

Carbon Dioxide (CO2) — A colorless, odorless, non-poisonous gas that is a normal part of the air. CO2 is the byproduct of the combustion, or oxidation, of carbon based fuels. CO2 is exhaled by humans and animals and is absorbed by green growing things and by the sea.

Coal — Black or brown rock, formed under pressure from organic fossils in prehistoric times, that is mined and burned to produce heat energy.

Cogeneration — Simultaneous production of heat energy and electrical or mechanical power from the same fuel in the same facility. A typical cogeneration facility produces electricity and steam or heat for industrial process use.

Combined-cycle plant — An electric generating station that uses waste heat from its gas turbines to produce steam for conventional steam turbines.

Combustion — Burning. Rapid oxidation, with the release of energy in the form of heat and light.

Criteria Pollutants — Air pollutants for which federal or state ambient air quality standards have been established.

Cubic foot — The most common unit of measurement of natural gas volume. One cubic foot of natural gas has an energy content of approximately 1,000 Btu.

District — local jurisdiction responsible for permitting and inspection of air pollution sources, such as power plants.

Deposition — Atmospheric deposition occurs in two forms: when polluted water droplets fall out of the atmosphere (wet deposition) or when nutrients scatter as dust and particles or as aerosols (dry deposition).

Electric generator — A device that converts heat, chemical, or mechanical energy into electricity.

Electricity — A property of the basic particles of matter. A form of energy having magnetic, radiant, and chemical effects. A current of electricity is created by a flow of charged particles.

Emissions standard — The maximum amount of a pollutant legally permitted to be discharged from a single source.

Energy consumption — The amount of energy consumed in the form in which it is acquired by the user. The term excludes electrical generation and distribution losses.

Entrainment — The flow of aquatic organisms in the cooling water that is pulled into and through the cooling system for a thermal power plant. For a hydro facility, it refers to the passage of aquatic organisms through the turbine.

Environmental discharge — The pollution outputs or impacts, such as tons of air emissions, acre feet of water used, or acres of displaced habitat, described cumulatively and by generation technology sector.

Environmental efficiency — Discharges or outputs per unit of energy capacity or production, such as tons of air pollutant per megawatt hour, acre feet of water per megawatt hour, acres of habitat loss per megawatt of capacity. Environmental efficiencies can also be expressed on a per capita or a gross domestic product basis.

Environmental quality effects — The relative effect of energy-related environmental performance on the environmental quality of regions, air basins, and watersheds. For example, adding new power plants to a region may or may not have an effect on attainment of air quality standards. Similarly, land used as a footprint for a power plant may or may not have a significant wildlife habitat impact locally.

Fired Generation — "Fired" generation are those technologies that rely on fuel combustion to generate electricity.

Fossil fuel — Petroleum oil, coal, or natural gas.

Fuel cell — A device that converts the chemical energy of fuel directly into electricity.

Generating station — A power plant.

Geothermal energy — Natural heat from within the earth, captured for production of electric power, space heating or industrial steam.

Gigawatt (GW) — One thousand megawatts or one million kilowatts.

Gigawatt-hour (GWh) — One thousand megawatt-hours or one million kilowatt-hours.

Grid — The transmission and distribution system that links power plants to customers.

Heat rate — A number that tells how efficient a fuel-burning power plant is. The heat rate equals the Btu content of the fuel input divided by the kilowatt hours of power output.

Hydroelectric power — Electricity produced by falling water that turns a turbine generator. Also referred to as hydro.

Impingement — The trapping of aquatic organisms on the intake screens or trash rack of a thermal or hydro facility.

Incremental hydro — Incremental hydro is the addition of generation at a hydropower facility that is already generating power. The incremental power may come from water not already in use for generation purposes (e.g., water in a fish passage system).

Internal combustion engine — or reciprocating engine, in which fuel is burned inside the engine. It differs from engines having an external furnace, such as a steam engine.

Kilowatt (kW) — One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment.

Kilowatt-hour (kWh) — The most commonly used unit of measure telling the amount of electricity consumed over time. It means one kilowatt of electricity supplied for one hour.

Landfill gas — Gas generated by the decomposition of municipal solid waste by anaerobic microorganisms in sanitary landfills, often captured for disposal in flares or for on-site electricity production fuel.

Load — The amount of electric power supplied to meet one or more end user's needs.

Megawatt (MW) — One thousand kilowatts.

mmBtu — million Btu

Megawatt-hour (MWh) — One thousand kilowatt hours.

Microturbine — Microturbines are small combustion turbines that produce between 25 kW and 500 kW of power.

Municipal electric utility or muni — A power utility system owned and operated by a local jurisdiction or public entity.

Natural gas — Hydrocarbon gas found in the earth, composed of methane, ethane, butane, propane, and other gases.

NOx — Oxides of nitrogen that are a chief component of air pollution produced by the burning of fossil fuels. Primarily NO and NO2.

New Source Review — Clean Air Act permit process for new sources for non-attainment air pollutants.

Nuclear energy — Power obtained by splitting heavy atoms (fission) or joining light atoms (fusion). A nuclear energy plant uses a controlled atomic chain reaction to produce heat. The heat is used to make steam to run conventional turbine generators.

Once-through cooling — Once-through cooling facilities withdraw cooling water from a river, stream, lake, reservoir, estuary, ocean, or other waterbody and return the used water to the source.

Ozone (O3**)** — A kind of oxygen that has three atoms per molecule instead of the usual two. Ozone is a poisonous gas and an irritant at Earth's surface, capable of damaging lungs and eyes. But the ozone layer in the stratosphere shields life on earth from deadly ultraviolet radiation from space.

Particulate matter — Particles, such as ash, that are released from combustion processes in exhaust gases at fossil-fuel plants and from mobile sources.

Peak load — The highest electrical demand within a particular period of time, for example, the electricity demand by air conditioners mid-afternoon on hot day.

Peak load power plant or peaking unit — A power generating station used to produce extra electricity during peak load times, but operate rarely or not at all other times of the year.

Photovoltaic cell — A semiconductor that converts light directly into electricity.

Power plant — An electric generating facility.

Prevention of Significant Deterioration (PSD) —Clean Air Act permit process for new sources for attainment air pollutants.

Pumped hydroelectric storage — Commercial method used for large-scale storage of power. During off-peak times, excess power is used to pump water to a reservoir. During peak times, the reservoir releases water to operate hydroelectric generators.

PURPA — The Public Utility Regulatory Policies Act of 1978 is implemented by the Federal Energy Regulatory Commission and the California Public Utilities Commission. Under PURPA, each electric utility is required to offer to purchase available electric energy from cogeneration and small power production facilities.

Qualifying facility — A cogeneration or small power producer, which, under federal law, has the right to sell its excess power output to the electric utility.

Renewable energy — Resources that constantly renew themselves or that are regarded as practically inexhaustible. These resources include solar, wind, geothermal, hydroelectric and waste-to-energy.

Repower — To modernize an existing electric generation facility.

Retrofit — Adding equipment to a facility or building after construction has been completed.

Solar thermal — The process of concentrating sunlight on a relatively small area to create the high temperatures needed to vaporize water to drive a turbine for electric power generation. Solar thermal systems may also be hybrid solar energy and natural gas-fired electric generating systems.

Simple-cycle plant — Uses gas to operate a turbine to generate electricity and does not recycle the waste heat generated by the process.

Steam electric plant — A power station in which steam is used to turn the turbines that generate electricity. The heat used to make the steam may come from burning fuel, using a controlled nuclear reaction, concentrating the sun's energy, tapping the earth's natural heat, or capturing industrial waste heat.

Supersaturation — The spilling of water over spillways which forces atmospheric gases into solution (gas bubbles), making the basin water supersaturated.

Thermal efficiency — The amount of fuel used to generate a unit of electricity in combustion technologies. Also described as the "heat rate" or fuel input-to-power output ratio.

Transboundary — A policy or agreement which crosses international or state borders and is in effect for both sides of the border.

Toxic air pollutant — An air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health.

Turbine generator — A device that uses steam, heated gases, water flow, or wind to cause spinning motion that activates electromagnetic forces and generates electricity.

Volt — A unit of electromotive force. It is the amount of force required to drive a steady current of one ampere through a resistance of one ohm.

Watt — A unit of measure of electric power at a point in time, as capacity or demand.

Watt hour — One watt of power expended for one hour.

Acronyms

AF — Acre-feet

AFC — Application for Certification

AQMD — Air Quality Management District

APCD — Air Pollution Control District

BACT — Best available control technology

BARCT — Best available retrofit control technology

BLM — Bureau of Land Management

Btu — British Thermal Unit

BUG — Back up emergency generator

CAA — Clean Air Act

CARB — California Air Resources Board

Cal/EPA — California Environmental Protection Agency

CTCC — Combustion turbine combined-cycle

CEQA — California Environmental Quality Act

CESA — California Endangered Species Act

CDF — California Department of Forestry

CDFG — California Department of Fish and Game

CDWR — California Department of Water Resources

CNPS — California Native Plant Society

CO — Carbon monoxide

CO2 — Carbon dioxide

CPUC — California Public Utilities Commission

CT — Combustion turbine

CVP — Central Valley Project

DG — Distributed generation

DSM — Demand side management

ECPA — Electric Consumers Protection Act

EIS — Environmental Impact Statement

EIR — Environmental Impact Report

EPA — U.S. Environmental Protection Agency

ESA — Endangered Species Act

F — Fahrenheit

FERC — Federal Energy Regulatory Commission

FGR — Flue gas recirculation

FPA — Federal Power Act

GPM — Gallons per minute

GSP — Gross state product

GWh — Gigawatt hour

H2S — Hydrogen sulfide

HCP — Habitat Conservation Plan

HRSG — Heat recovery steam generator

IBEW — International Brotherhood of Electrical Workers

ISO — Independent System Operator

ISCST3 — Industrial Source complex Short term Version 3

kWh — Kilowatt hour

KGRA — Known Geothermal Resource Area

LADWP — Los Angeles Department of Water and Power

LLC — Limited liability company

mmBtu – million Btu

MGD — Million gallons per day

MSCP — Multispecies Conservation Plan

MW — Megawatt

MWh — Megawatt hour

NCCP - Natural Communities Conservation Plan

NH3 — Ammonia

NO — nitric oxide

NO2 — Nitrogen dioxide

NOx — Nitrogen oxides

NMFS — National Marine Fisheries Service

NPDES — National Pollutant Discharge limination System

O3 — Ozone

PG&E — Pacific Gas and Electric

PM2.5 — Particulate matter less than 2.5 microns

PM10 — Particulate matter less than 10 microns

PSI — Pounds per square inch

PURPA — Public Utility Regulatory Policies Act

PV — Photovoltaic

RMR — Reliability Must Run

ROC — Reactive organic compounds

ROW — Right of Way

SBE — State Board of Equalization

SCE — Southern California Edison

SCR — Selective catalytic reduction

SDG&E — San Diego Gas and Electric

SFEC — San Francisco Energy Company

SMUD — Sacramento Municipal Utility District

SO2 — Sulfur Dioxide

SWP — State Water Project

SWRCB — State Water Resources Control Board

TMDL— Total maximum daily loading

TNC — The Nature Conservancy

U.S.EPA — U.S. Environmental Protection Agency

U.S.FWS — U.S. Fish and Wildlife Service

WRA - Wind Resource Area

WECC — Western Electricity Coordinating Council, formerly the WSCC - Western System Coordinating Council

WTE — Waste to Energy